



2012 Assessment of the Biology, Habitat and Chemistry of Select Streams and Watersheds of Chesterfield County, Virginia



Marine Springs Branch Downstream of Kings Farm Drive, April 3rd 2012

**Chesterfield County
Department of Environmental Engineering
Water Quality Section**

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Executive Summary

This report presents the physical, chemical and biological water quality data collected by Chesterfield County's Department of Environmental Engineering - Water Quality Section for the period of March 27 to April 5, 2012. As a component of Chesterfield County's VPDES Permit VA0088609, Watershed Assessment and Stream Protection (WASP) Program, 15 streams were investigated during the spring of 2012 to assess the condition of county waters.

Benthic macroinvertebrate data for monitored watersheds were analyzed and tabulated. A total of 19,184 individual benthic macroinvertebrates representing 79 distinct taxa were recovered in 2012. The 20 most common taxa reflected a general condition indicative of fair to moderate water quality within these monitored watersheds.

A summary of the bioassessment categories of the monitored watersheds indicated that 80 percent of sites sampled (n=12) scored in the two lower categories during 2012. Seven sites were classified as "Severely Impaired" and five were assessed as "Moderately Impaired." One site in the Appomattox River watershed (APR-04) exhibited a "Slightly Impaired" bioassessment condition and two sites (APR-02 and MCX-02) were assessed as "Non-Impaired" in 2012. The overall best bioassessment scores were noted in the Appomattox River watershed where two of the four sites investigated were characterized as either "Slightly Impaired" or "Non-Impaired."

Site comparisons made using the VSCI score derived "Aquatic Life Use Tiers" and the Chesterfield County bioassessment conditions demonstrated eleven sites where the VSCI and Chesterfield County bioassessment categories were similar (73%) and four (27%) where the resulting VSCI condition was lower. A Pearson's Correlation Analysis of these 15 observations indicated that there was a statistically significant ($p < 0.0001$) and strong ($r = 0.98$) positive correlation between these two methods.

A summary of the habitat categories of each monitored watershed indicated that the majority of sites assessed (eight) scored as "Supporting" in 2012 (Figure 2). Five sites were assessed as "Partially Supporting" and two demonstrated a "Non-Supporting" condition. There were no reaches investigated in 2012 that scored a value indicating a "Comparable to Reference" status.

A comprehensive suite of chemical parameters was collected during 2012. Instream measurements of dissolved oxygen, pH, conductivity/total dissolved solids and temperature yielded values that were within Virginia state water quality standards and normally expected ranges for Chesterfield County during 2012. Hardness measurements ranged from 9.3 to 53.7 mg/L as CaCO_3 and indicated "soft" water throughout the monitored watersheds.

Nutrient concentrations varied among sites and within watersheds during 2012. The median total ammonia nitrogen value for all sites in 2012 was 0.04 mg/L as N with individual observations ranging from < 0.01 mg/L as N at Tributary to Michaux Creek

(MCX-04) to 0.47 mg/L as N at Stoney Creek (APR-02). The median nitrate+nitrite nitrogen concentration for all reaches in 2012 was 0.17 mg/L as N, with individual measurements ranging from 0.02 mg/L as N at Cattle Creek (APR-04) to 0.80 mg/L as N at Marine Spring Branch (JR-08). Measureable levels of dissolved phosphorus were observed at all sites in 2012 ranging from 0.02 mg/L as P at Tributary to the James River (JR-06) to 0.24 mg/L as P at Fleet Branch (APR-01). The median value observed for all sites assessed was 0.05 mg/L as P. Total phosphorus concentrations ranged from 0.03 mg/L as P at the two Tributary to the James River sites within the Robious Landing Park (JR-06 and JR-07) to 0.37 mg/L at Fleets Branch (APR-01). The median total phosphorus value was measured as 0.06 mg/L as P.

The levels of total suspended solids ranged from <0.01 mg/L at Tributary to the James River (JR-07) and at Michaux Creek (MCX-01) to 34.1 mg/L at the uppermost Michaux Creek site (MCX-05). Biochemical Oxygen Demand determinations conducted in 2012 were generally low with values ranging from <2.0 mg/L at ten sites to 11.8 mg/L at the uppermost Michaux Creek site (MCX-05). Fecal coliform densities ranged from < 2 MPN/100ml at Spring Creek (JR-04) and Roberts Branch (JR-09) to \geq 1600 MPN/100ml at Tributary to the James River (JR-06). During 2012, three streams had *E. coli* measurements that were greater than the 235 MPN/100ml state standard for recreational contact. These sites were Fleets Branch (APR-01; 235.9 MPN/100ml), Tributary to the James River at Ashwell Drive (JR-05; 261.3 MPN/100ml) and the Tributary to the James River at Robious Landing Park (JR-06; 686.7 MPN/100ml). A revisit to these sites confirmed increased densities of *E.coli* at the Fleets Branch reach (480 CFUs/100ml) and indicated no violation of the state *E. coli* standard at the two Tributary to the James River reaches.

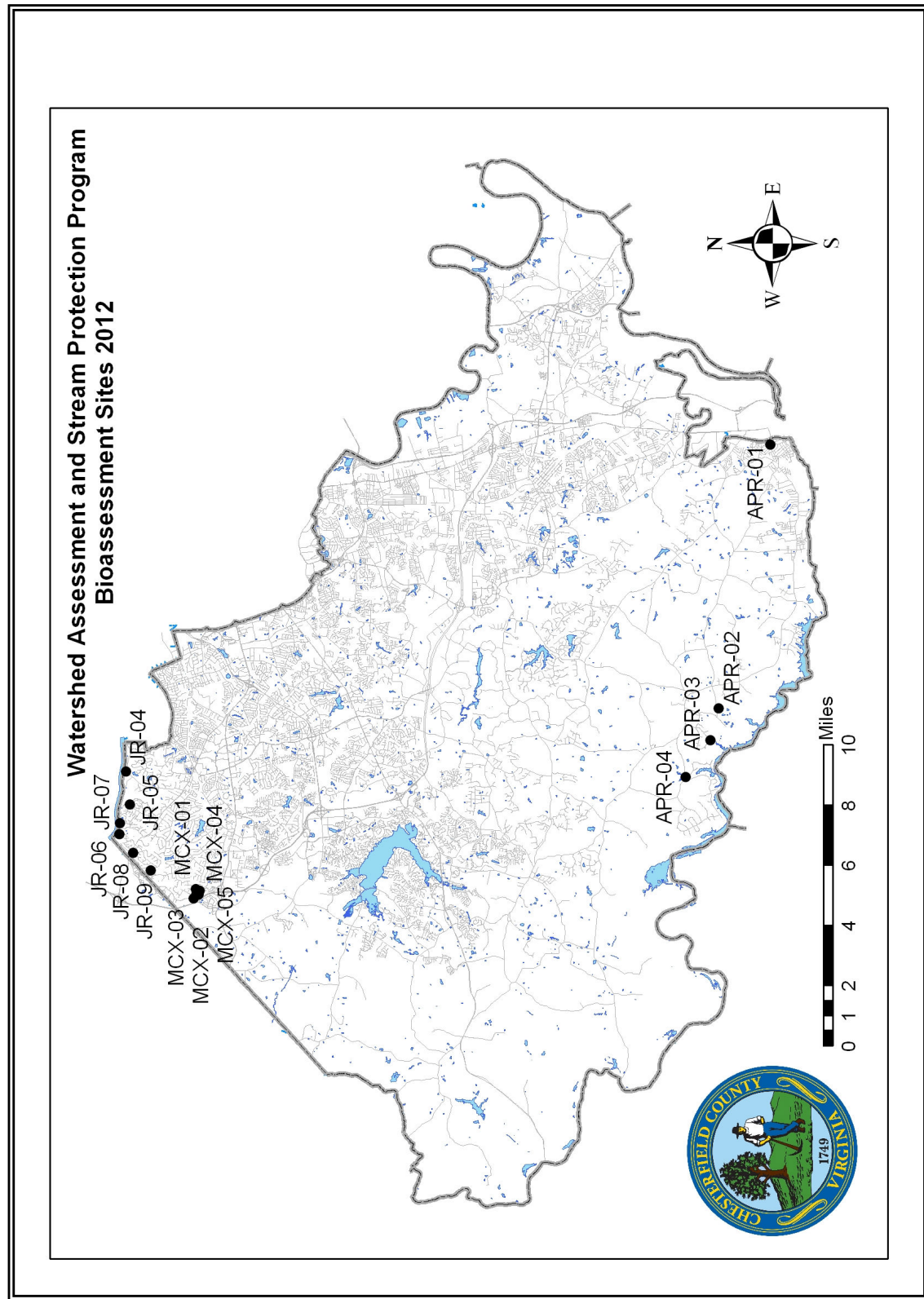
Introduction

This report presents the physical, chemical and biological water quality data collected by Chesterfield County's Department of Environmental Engineering - Water Quality Section for the period of March 27 to April 5, 2012. As a component of Chesterfield County's VPDES Permit VA0088609, Watershed Assessment and Stream Protection (WASP) Program, 15 streams were investigated during the spring of 2012 to assess the condition of county waters.

In 2002, Chesterfield County implemented a watershed-based approach to permit required sampling. Due to observed data inconsistencies and concerns regarding the quality of infrequent sample collection, emphasis was shifted away from the traditional quarterly "end of pipe" stormwater monitoring regime to the comprehensive stream and watershed level assessment procedure. This sampling protocol has remained in effect for the past ten years with assessed watersheds added on a three-year rotational basis. Fifteen new sites were investigated in three watersheds in 2012; four in direct drainages to the Appomattox River, six in direct drainages to the James River and five within the Michaux Creek watershed (Table 1). Locations of these new sites are depicted in Map 1 on the following page.

Table 1. Site locations and physiographic data, 2012.

<u>Site Number</u>	<u>Stream</u>	<u>Station Location</u>	<u>Latitude</u>	<u>Longitude</u>	<u>Stream Order</u>
APR-01	Fleets Branch	On VSU Campus Downstream of East River Road	37.243041	77.419501	1
APR-02	Stoney Creek	Downstream of Trents Bridge Road	37.269374	77.578601	2
APR-03	Tributary to Appomattox River	Downstream of St. Audries Drive	37.273398	77.597667	3
APR-04	Cattle Creek	Downstream of Ivey Mill Road	37.285507	77.619649	3
JR-04	Spring Creek	Downstream of Old Gun Road East	37.555167	77.613086	2
JR-05	Tributary to James River	Downstream of Ashwell Drive	37.553473	77.633059	1
JR-06	Tributary to James River	Robious Landing Park East of James River Road	37.558621	77.651147	2
JR-07	Tributary to James River	Robious Landing Park West of James River Road	37.558378	77.644592	1
JR-08	Marine Spring Branch	Downstream of Kings Farm Drive	37.552002	77.662481	2
JR-09	Roberts Branch	Upstream of Crossings Way	37.543812	77.673236	2
MCX-01	Michaux Creek	East of RT288	37.521841	77.687669	3
MCX-02	Tributary to Michaux Creek	East of RT288 - Upstream of MCX-01	37.520870	77.688152	1
MCX-03	Tributary to Michaux Creek	Southwest of North Otterdale Road	37.523228	77.690353	1
MCX-04	Tributary to Michaux Creek	Downstream of Lasingham Drive	37.522158	77.684781	2
MCX-05	Michaux Creek	End of North Otterdale Road	37.520242	77.685668	3



Map 1. Chesterfield County Bioassessment Sites, 2012.

A critical element of the WASP program has been the reference condition watershed. In 1999 the county's consultant, CH2MHill selected 26 sites within the Swift Creek watershed that were representative of stream size and type as well as land use present throughout the county (CH2M Hill 2000). Benthic macroinvertebrate and habitat data from these sites were used to create a reference condition from which other streams in Chesterfield County could be assessed. These sites were revisited in 2000 by staff from CH2M Hill (CH2M Hill 2001). Water Quality Section Staff continued to sample subsets of these original sites from 2002 to 2005 (OWQ 2004, 2005 and 2006) for further comparison and improvement of the reference condition. Collection of reference condition data and refinement was finalized in 2005 with the establishment of bioassessment and habitat assessment scoring criteria that would be used for future comparisons. In 2006, the monitoring emphasis shifted from the refinement of the reference condition to the use of the finalized reference criteria to investigate sites within different watersheds.

Methods

Stream physical parameters were measured *in situ* by use of a Hydrolab[®] MS5 Minisonde water quality multiprobe in conjunction with a Surveyor 4a data logger system. Parameters measured in the field included dissolved oxygen, pH, conductivity, total dissolved solids and temperature. A semi-quantitative measure of flow was also obtained by recording the time it took for a float to travel a measured distance (one meter).

Water samples for eight permit-required parameters were obtained by county staff from the bank of each site just below the surface of the water by hand. In 2012, analysis for *E. coli* was continued voluntarily to complement the permit-required parameters and to better reflect the current State of Virginia bacterial water quality standards. Appropriate pre-labeled containers specific to each parameter were obtained from the county's contract laboratory (Primary Laboratories Inc.). Samples were immediately placed in a cooler on ice for transfer to Primary Laboratories where sample analysis was conducted. Care was taken in the field and during transfer to adhere to analytical holding times for specific chemistries. Chain of custody forms provided by Primary Laboratories were completed prior to delivery to the laboratory and were signed at sample transfer by each party. Copies were then archived in the Water Quality Section's files for documentation. A summary of the tests, methods and reporting limits is outlined in Table 2.

Table 2. Parameters and Analytical Methods, 2012.

Parameter	Analytical Method	Reporting Limit	Analysts
Dissolved Oxygen	Probe: Hydrolab [®] Minisonde	0.1 mg/L*	Chesterfield County WQS
pH	Probe: Hydrolab [®] Minisonde	0.2 units*	Chesterfield County WQS
Conductivity	Probe: Hydrolab [®] Minisonde	1.0 μ S/cm*	Chesterfield County WQS
Total Dissolved Solids	Probe: Hydrolab [®] Minisonde	0.1 mg/L*	Chesterfield County WQS
Temperature	Probe: Hydrolab [®] Minisonde	0.1 °C*	Chesterfield County WQS
Flow	USGS: Float	0.01 m/s	Chesterfield County WQS
Hardness	EPA 130.2	0.1 mg/L as CaCO ₃	Primary Laboratories
Total Ammonia	EPA 350.3	0.01 mg/L as N	Primary Laboratories
Nitrate/Nitrite	EPA 353.3	0.01 mg/L as N	Primary Laboratories
Dissolved Phosphorus	EPA 365.2	0.01 mg/L as P	Primary Laboratories
Total Phosphorus	EPA 365.2	0.01 mg/L as P	Primary Laboratories
Total Suspended Solids	EPA 160.2	1.0 mg/L	Primary Laboratories
Biochemical Oxygen Demand	EPA 405.1	2.0 mg/L	Primary Laboratories
Fecal Coliform	Standard Methods 9221 E.	2 MPN per 100ml	Primary Laboratories
<i>E. coli</i>	Standard Methods 9223 B.	1.0 MPN per 100ml	Primary Laboratories

*When a method detection limit was not applicable for a parameter, it was replaced by an estimation of accuracy based on manufacturer's specifications.

Sampling for benthic macroinvertebrates followed the guidelines outlined in the Environmental Protection Agency's Revised Rapid Bioassessment Protocol (EPA, 1999). Monitoring occurred during the spring (March/April) since biological surveys at this time tend to yield a better recovery of large, near-mature invertebrates that are easier and more accurately identified. As in past years, sampling was conducted on a multi-habitat basis. A total of twenty jabs and/or kicks with a D-frame dip net were conducted along an approximate 100-meter sample reach relative to the proportion of represented habitat. Aquatic organisms entrained in the net were then separated from coarse particulate organic matter in the field by use of a series of sieve buckets. Large, easily identified

animals such as crayfish and vertebrates were noted on field sheets and returned to the stream. Samples were placed in double polyethylene freezer bags, labeled and preserved in the field with 95% ethanol.

Upon return to the laboratory, samples were stored at $<4.0^{\circ}\text{C}$ in the laboratory refrigerator. Samples were washed through a #30 sieve with tap water to remove ethanol and placed in a white-bottomed tray. All visible benthic macroinvertebrates were removed from the debris, counted and placed in a labeled jar. Benthic macroinvertebrates were then sorted, identified to the lowest possible taxonomic level (most often genus) and enumerated using a 40x binocular microscope. Midge larvae (*Chironomidae*) were identified to family level rather than genus due to time and laboratory constraints. Sample composition was entered into EXCEL spreadsheets and metrics were calculated for each site.

Benthic Macroinvertebrate Metric Calculations and Analysis

Seven benthic macroinvertebrate metrics first established by CH2M Hill (2000) form the basis of the assessment calculations. These metrics include:

- Total Taxa Richness (variety of different organisms present)
- EPT Index (summarizes the taxa richness of pollution-sensitive species)
- Percent Contribution of Dominant Taxon (a measure of community balance)
- Modified Hilsenhoff Biotic Index (assigns a single value from 0 to 10 to describe a benthic macroinvertebrate community's tolerance to organic pollutants)
- Percent Collector/Gatherers (Percent of the macrobenthos that "gather" food)
- Percent Predators (Percent of the macrobenthos within the predator functional feeding group)
- Percent Scrapers (Percent of macrobenthos that "scrape" their food from a substrate surface)

From 1999 to 2005, metric score development and refinement followed the protocol used by CH2M Hill (2000), USEPA (1999) and the USGS (1999). A trisectional approach was utilized where metric values were normalized into unit-less scores by separating metric value ranges into three categories assigned scores of "5", "3", or "1". Metric scoring criteria were derived from 1999 through 2005 reference site data (Swift Creek watershed) by using cumulative percentile analysis. The top scoring category, associated with the maximum score of "5", represented values equal to or exceeding the 75th percentile of reference sites scores for metrics that decreased in response to disturbance, or values less than or equal to the 25th percentile of reference sites scores for metrics that increased in response to disturbance. The low-end score, in this case "1", was likewise based on the 25th percentile (metrics that decrease with impairment) or 75th percentile (metrics that increase with impairment), for all sampling sites for a particular metric. The middle score of "3" encompassed the intermediate range. This produced a rather conservative index score (CH2M Hill, 2000). Table 3 outlines the results of the finalized 2005 scoring criteria refinement that was used for the analysis of the 2012 data.

Table 3. Finalized Bioassessment Scoring Criteria based on Swift Creek watershed benthic macroinvertebrate data 1999-2005.

Metric	Score		
	5	3	1
Total Taxa Richness	≥ 31	30 – 20	≤ 19
EPT Taxa Richness	≥ 12	11 – 6	≤ 5
% Dominant Taxa	≤ 34.1	34.2 – 56.4	≥ 56.5
Hilsenhoff Biotic Index (Modified)	≤ 5.2	5.3 – 5.9	≥ 6.0
% Gatherers	≤ 51.4	51.5 – 80.0	≥ 80.1
% Predators	≥ 8.9	8.8 – 2.5	≤ 2.4
% Scrapers	≥ 7.4	7.3 – 0.8	≤ 0.7

The final index score for a site was calculated by summing the individual metric scores and compared to the “perfect score” of 35 (7 metrics x “5”) to obtain a percent comparison value. From these comparison values cumulative percentile plots were generated to determine ranges for assigning impairment categories. A quadrisection approach was used based on upper and lower 10th percentiles and the median value to generate four impairment categories (Table 4).

Table 4. Finalized Evaluation Criteria for Chesterfield County Stream Biological Assessment established 2005.

Percent Comparable to		
Reference Condition	Biological Condition	Biological Attributes
$\geq 82.9 \%$	Non-Impaired	Comparable to the best attainable situation to be expected within the watershed
60.0 – 82.8 %	Slightly Impaired	Community structure and function less than expected
37.2 – 59.9 %	Moderately Impaired	Fewer species present, loss of intolerant forms, increase in tolerant taxa, reduction in EPT index
$\leq 37.1 \%$	Severely Impaired	Few species present. If high densities of organisms, then dominated by one or two taxa

It is of interesting note that the final evaluation criteria scores remained precisely the same from 2003 to 2005, reflecting the strength of the reference condition criteria. Finally, index scores derived from the metrics were calculated for each monitoring site and were then compared against the biological reference condition and described in narrative form based on the percent comparability and the criteria provided in Table 4.

“Best attainable” reference conditions were determined for each metric that could be applied to all streams of the county independent of stream order. For this, a series of linear regressions of each metric against stream order was performed to confirm that one reference scoring condition could be used (Table 5). Reference stream data from the Swift Creek watershed from 1999 through 2005 were included in this analysis to increase the sample pool. The resulting coefficients of determination (r^2) values were then reviewed to identify any strong relationships that precluded the establishment of a single reference condition. Results of this analysis are outlined in Table 5 and indicate there were no strong relationships between metrics and stream order. As a result, all Swift Creek watershed sites were pooled together for development of the scoring criteria resulting in one reference condition.

Table 5. Bioassessment metrics versus stream order, 1999-2005.

Metric	r^2
Total Taxa Richness	0.0214
EPT Taxa Richness	0.0002
% Dominant Taxa	0.0141
Hilsenhoff Biotic Index (Modified)	0.0020
% Collector/Gatherers	0.0063
% Predators	0.0002
% Scrapers	0.0417

All metrics were analyzed using Pearson’s Correlation to determine if any redundancies existed. This procedure was first conducted by CH2M Hill in 1999 and was used to exclude metrics that were not unique. It was necessary to conduct this analysis again in 2002 and 2003 to reevaluate the metrics due to slight variances from CH2M Hill’s original taxonomic resolution. It was then conducted again in 2004 and 2005 to verify the relationships observed in the past. Following CH2M Hill (2000), any resulting Pearson’s correlation coefficient (r) value > 0.90 indicated redundant metrics. All of the metrics calculated in 2005 were below this threshold (Table 6). As in past reports, the greatest Pearson’s correlation coefficients were observed between total taxa richness and EPT taxa richness, and HBI index score and EPT taxa richness (Table 6).

Table 6. Bioassessment metrics redundancy matrix, spring 1999 to 2005. Values represent the Pearson's correlation coefficient (*r*).

	Total Taxa Richness	EPT Taxa Richness	% Dominant Taxa	HBI Index	% Gatherers	% Predators	% Scrapers
Total Taxa Richness	*	*	*	*	*	*	*
EPT Taxa Richness	0.853	*	*	*	*	*	*
% Dominant Taxa	-0.212	-0.190	*	*	*	*	*
HBI Index	-0.392	-0.557	0.158	*	*	*	*
% Collector/Gatherer	-0.227	-0.195	0.396	0.405	*	*	*
% Predator	0.273	0.166	-0.480	-0.039	-0.382	*	*
% Scrapers	0.060	-0.035	-0.165	0.024	-0.262	0.086	*

Virginia Stream Condition Index (VSCI)

As in the past four years, the benthic macroinvertebrate data collected in 2012 was also analyzed using the stream condition index methodology developed by Tetra Tech, Inc for upland (non-coastal) streams in Virginia. This index has been described as “a primary indicator of ecosystem health” that can “identify impairment with respect to the reference or natural condition” (Tetra Tech 2003). The protocol was initially developed and tested with a comprehensive statewide data set of 1671 benthic macroinvertebrate samples collected from 1994 through 2002. The methodology was subsequently validated in 2006 with a probabilistic dataset using independent samples from 350 data reaches (VADEQ 2006) collected from 2001 to 2004. The index consists of eight core metrics, many of which are similar to those already used by the county. These metrics include:

- Total Taxa Richness (variety of different organisms present)
- EPT Taxa Richness (summarizes the taxa richness of pollution-sensitive species)
- Percent Ephemeroptera (proportion of pollution sensitive mayflies)
- Percent Plecoptera+Trichoptera - *Hydropsychidae* species (proportion of pollution sensitive stoneflies and caddisflies)
- Percent *Chironomidae* (proportion of pollution tolerant midge larvae)
- Percent Top Two Dominant Taxa (a measure of community balance)
- Modified Family Level Hilsenhoff Biotic Index (assigns a single value from 0 to 10 to describe a benthic macroinvertebrate community's tolerance to organic pollutants)
- Percent Scrapers (Percent of macrobenthos that “scrape” their food from a substrate surface)

The benthic macroinvertebrate sample composition was entered into EXCEL spreadsheets and the VSCI metrics were calculated for each site. For this exercise, family level taxonomic resolution was required and calculated for each metric score

determination. The final VSCI value was the mean of the eight separate calculated unit-less scores. From this VSCI value, “Aquatic Life Use Tiers” were discerned (Table 7) and compared to the county’s bioassessment determinations for compatibility in categorizing stream condition.

Table 7. Virginia Stream Condition Index Aquatic Life Use Tiers (from VADEQ 2006) and comparable Chesterfield County Bioassessment Categories

Index Score	Tier	Comparable Bioassessment Category
≥73	Excellent	Non-Impaired
60 – 72	Good	Slightly Impaired
43 – 59	Stress	Moderately Impaired
≤42	Severe Stress	Severely Impaired

Habitat Metric Calculations and Analysis

The EPA’s Habitat Assessment for Low Gradient Streams has been used since 1999 to describe the instream and riparian characteristics of the monitored sites. This approach assigns scores to ten (10) individual parameters that are summed to obtain a final overall value. Worksheets detailing these parameters are completed in the field by two independent analysts. The resulting parameter scores of each analyst are subsequently averaged and summed. From 1999 to 2005, the averaged scores from the reference watershed (Swift Creek) were analyzed using cumulative percentile plots to determine ranges for assigning impairment categories for the county. A quadrisection approach was used based on upper and lower 25th percentiles and the median value to generate four impairment categories (Table 8). Total habitat scores obtained in 2012 were compared against these criteria.

Quality Assurance/Quality Control

The Hydrolab[®] Minisonde multiprobe was calibrated using commercially prepared buffer solutions prior to deployment to the field. Specific pre-labeled bottles containing preservative provided by the contract laboratory were used to obtain samples. In all instances, sample collection and preservation followed protocols outlined in *Standard Methods*. Contract laboratory chain of custody forms were filled out in the field and signed by the appropriate parties upon delivery and receipt. Contract laboratory results were reviewed and data obtained was entered into an EXCEL spreadsheet. Results of contract laboratory QA/QC studies were provided and carefully reviewed. All records and field sheets were double checked for accuracy and archived in the Water Quality Section’s files.

Table 8. Finalized Evaluation Criteria for Chesterfield County Habitat Assessment established 2005.

Total Habitat Score	Category	General Habitat Attributes
≥ 161	Comparable to Reference	Stream substrate and instream cover optimal for the maintenance of the aquatic community; Channel flows naturally with strong sinuosity; Streambanks well vegetated and stable; Riparian zone wide and without impacts
147 - 160	Supporting	Stream substrate and instream cover sub-optimal; Channel exhibits slight modification and good sinuosity; Small amount of erosion present; Riparian zone slightly impacted
132 - 146	Partially Supporting	Stream substrate and instream cover marginal; Channel exhibits modifications and weak sinuosity; Moderate amounts of erosion present; Riparian zone substantially impacted
≤ 131	Non-Supporting	Stream substrate and instream cover poor; Channel exhibits extensive modification and poor sinuosity; large amounts of erosion present; Riparian zone heavily impacted

Unprocessed benthic macroinvertebrate samples were stored at $\leq 4^{\circ}\text{C}$ in separate containers and labeled with site, date collected and collector's initials. Processed samples were stored in 95% ethanol in individual 60 ml jars labeled with site information, date processed, the date taxonomic identification was completed and analyst's initials. Benthic macroinvertebrate samples were processed carefully and double-checked for organisms prior to disposal of residual debris. Taxonomic keys and a reference collection were used to verify taxonomic identifications. Specimens of benthic macroinvertebrates added to the original reference collection and/or unknown taxa were brought to Virginia Commonwealth University's Aquatic Ecology Laboratory for taxonomic verification/identification. Data entry into the EXCEL spreadsheets for the benthic macroinvertebrates and habitat parameters was double checked for accuracy. Replicate samples were obtained for benthic macroinvertebrates and analyzed as individual samples for documentation of process precision and accuracy. Similarly, replicate habitat field sheets were completed and compared to initial assessments.

Results

The following pages describe each site and contain a summary of the observations made during 2012. Field data sheets and associated notes are located in Appendix A following this report.

Direct Drainages to the Appomattox River

The following pages summarize the findings during 2012 at four newly established sites that flow directly to the Appomattox River. Photos depict the upstream view of the site unless otherwise noted. Left and right banks are referenced from the perspective looking upstream.

Site Number APR-01

Stream: Fleets Branch

Site: Virginia State University
downstream of East River Road

Watershed: Appomattox River

Subwatershed: Fleets Branch

Approximate Drainage Area
(acres): 198

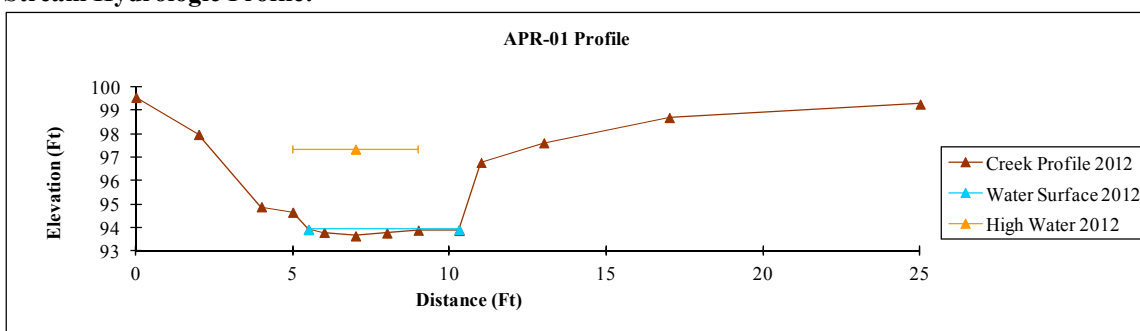
Stream Order: 1

Ecoregion: Deep Coastal Plain (4)

Landuse: Residential, University



Stream Hydrologic Profile:



Bioassessment:

The bioassessment in 2012 indicated a “Severely Impaired status. Total taxa richness (n=19) and EPT taxa richness (n=1) were low with 71.2 percent of the sample comprised of midge larvae (*Chironomidae*; n=632). Despite the depressed richness observations, the Hilsenhoff Biotic Index value (5.8) indicated a community comprised of a mix of pollution tolerant and pollution sensitive organisms. The large quantity of midge larvae observed contributed substantially to the high proportion of collector/gatherers represented in the sample (83.7%). Predator (2.5%) and scraper (3.9%) taxa were observed in moderate proportions during 2012. Other taxa present in numbers included segmented worms (*Oligochaetes*), blackfly larvae (*Simulium*) and riffle beetles (*Stenelmis*).

Habitat Assessment:

The habitat assessment score at this site was the lowest observed among all values in 2012 and indicated a “Non-Supporting” condition for the reach. The streambed was comprised largely of cobbles with the epifaunal substrate metric returning a suboptimal value. Pool substrate was characterized by a mix of soft sand/sediment and the reach contained a preponderance of shallow pools. Sediment deposition was noticeable throughout the site’s length. The channel flow status was optimal. The reach exhibited historic channelization and as a result lacked strong sinuosity. Both stream banks exhibited obvious areas of scour/erosion and were sparsely vegetated. The riparian areas on either side were narrow with parking lots and university buildings present. A buffer replanting was present along the right bank.

Water Quality:

Concentrations of total ammonia (0.38 mg/L as N) and nitrate+nitrite nitrogen (0.56 mg/L as N) were high. The levels of both dissolved (0.24 mg/L as P) and total phosphorus (0.37 mg/L as P) were the greatest observed among all sites in 2012. The elevated concentrations of nitrogen and phosphorus indicated a high degree of nutrient enrichment. The observed *E. coli* density (235.9 MPN/100ml) was in excess of the Virginia DEQ water quality standard for contact recreation. All other chemistries sampled were reflective of excellent water quality.

Site Number APR-02

Stream: Stoney Creek

Site: Downstream of Trents Bridge Road

Watershed: Appomattox River

Subwatershed: Stoney Creek

Approximate Drainage Area (acres):
606

Stream Order: 2

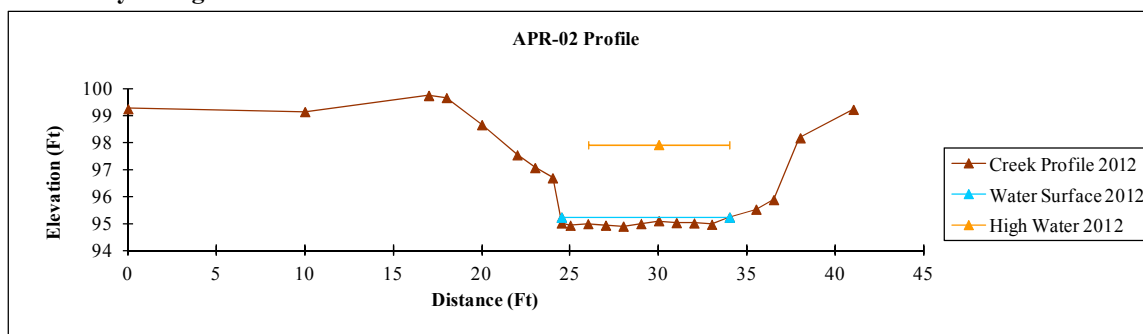
Ecoregion: Piedmont (5)

Landuse: Forest, Residential, Scout Camp



View is downstream

Stream Hydrologic Profile:



Bioassessment:

In 2012, the greatest bioassessment score (82.9%) was observed at this site reflecting a “Non-Impaired” condition. Total taxa richness (n=40) was the second greatest noted and EPT taxa richness (n=15) was tied for the highest value observed among all sites. The community composition was well balanced with only 31.1% of the sample comprised of a single animal (*Chironomidae*; n=537). The Hilsenhoff Biotic Index value reflected a community comprised largely of pollution sensitive taxa. The proportion of collector/gatherers was the lowest observed among all sites (57.0%) and the percentages of predator (8.6%) and scraper (2.8%) organisms were well represented. All metrics were suggestive of a fully functional and strong benthic community. Among other macroinvertebrates well represented were *Amphinemura* stonefly larvae, *Acentrella* mayfly larvae and scuds (*Crangonyx*).

Habitat Assessment:

The habitat assessment in 2012 indicated a “Supporting” condition. The stream reach exhibited optimal substrate and instream habitat characteristics (*e.g.* non-embedded gravel/cobbles, snags and woody debris) for the maintenance of the benthic macroinvertebrate community. Pool substrate was comprised largely of firm sand/gravel and the majority of the pools within the reach were large and deep. A slight degree of sediment deposition was observed throughout the site. The channel flow status was optimal with water reaching the base of both banks and sinuosity was good. The stream was in its natural state with no recent or apparent alterations. Both banks were stable and well vegetated with only sparse areas of erosion noted. Riparian areas were completely undisturbed.

Water Quality:

The concentration of total ammonia (0.47 mg/L as N) was the greatest observed at all sites in 2012. Likewise, dissolved (0.18 mg/L as P) and total (0.24 mg/L as P) phosphorus concentrations were elevated suggesting an unknown source of upstream nutrient enrichment. All other chemistries sampled were reflective of excellent water quality.

Site Number APR-03

Stream: Tributary to the Appomattox

Site: Downstream of St. Audries Drive

Watershed: Appomattox River

Subwatershed: Lake Chesdin

Approximate Drainage Area (acres): 516

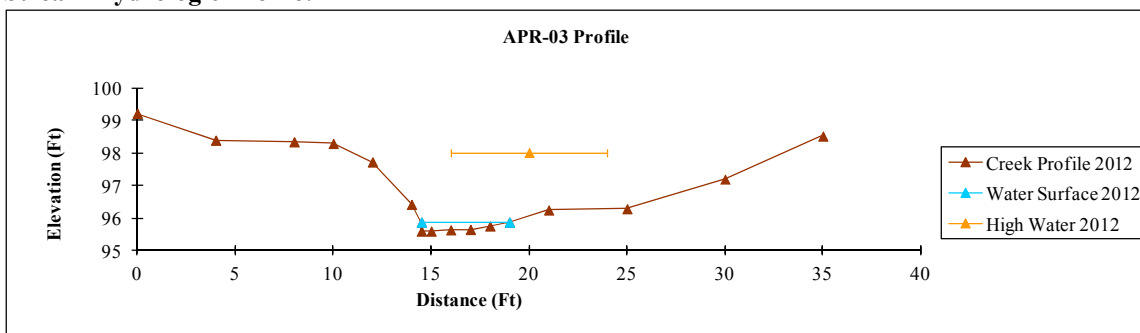
Stream Order: 3

Ecoregion: Piedmont (5)

Landuse: Forest, Residential



Stream Hydrologic Profile:



Bioassessment:

The bioassessment in 2012 indicated a “Moderately Impaired” status. Total taxa richness (n=28) was good and EPT taxa richness (n=13) was excellent. Midge larvae (*Chironomidae*; n=688) accounted for 60.6% of the organisms recovered and the Hilsenhoff Biotic Index score was high (6.0), demonstrating a community comprised largely of pollution tolerant organisms. The large quantity of midge larvae observed contributed substantially to the high proportion of collector/gatherers represented in the sample (82.8%). An excellent proportion of predators (11.1%) were observed due primarily to strong numbers of biting midges (*Bezzia*) and *Alloperla* stonefly larvae. Scraper taxa were present in moderate proportions (2.8%). Other notable benthic macroinvertebrates recovered included scuds (*Crangonyx*) and *Ephemerella* mayfly larvae.

Habitat Assessment:

The habitat assessment in 2012 indicated a “Supporting” condition. Overall reach habitat characteristics were very similar to site APR-02. The stream reach exhibited optimal substrate and instream habitat characteristics (e.g. non-embedded gravel/cobbles, snags and woody debris) for the maintenance of the benthic macroinvertebrate community. Pool substrate was comprised largely of firm sand/gravel and the majority of the pools within the reach were large and deep. A moderate degree of sediment deposition was observed throughout the site. The channel flow status was optimal with water reaching the base of both banks and sinuosity was excellent. The stream was in its natural state with no recent or apparent alterations. Both banks were stable and well vegetated with only sparse areas of erosion noted. Riparian areas were undisturbed.

Water Quality:

The calcium hardness value (9.3 mg/L CaCO₃) was the lowest observed at all sites indicating very soft water. Both dissolved (0.20 mg/L as P) and total (0.30 mg/L as P) phosphorus concentrations were elevated suggesting an unknown source of upstream phosphorus enrichment. All other chemistries sampled were reflective of excellent water quality.

Site Number APR-04

Stream: Cattle Creek

Site: Downstream of Ivey Mill Road

Watershed: Appomattox River

Subwatershed: Cattle Creek

Approximate Drainage Area (acres):
1528

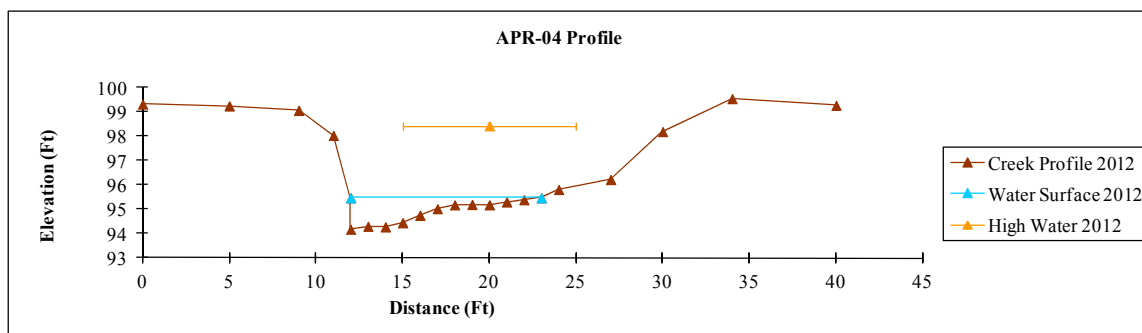
Stream Order: 3

Ecoregion: Piedmont (5)

Landuse: Forest, Residential



Stream Hydrologic Profile:



Bioassessment:

In 2012, the bioassessment at this site indicated a “Slightly Impaired” condition. Total taxa richness (n=42) was the greatest observed at all sites and EPT taxa richness (n=14) was likewise excellent. Midge larvae (*Chironomidae*; n=752) accounted for 57.3% of the organisms recovered and the Hilsenhoff Biotic Index score was high (6.0), demonstrating a community comprised largely of pollution tolerant organisms. Moderate percentages of collector/gatherer (66.9%) and scraper (4.9%) taxa were present and an excellent proportion of predator organisms (12.0%) were noted. The benthic macroinvertebrate community was generally well balanced and functional. Among the most abundant macroinvertebrates in the sample were fingernail clams (*Pisidium*), biting midge larvae (*Bezzia*) and segmented worms (*Oligochaetes*).

Habitat Assessment:

The habitat assessment in 2012 indicated a “Supporting” condition. With a few exceptions, the overall reach habitat characteristics were very similar to sites APR-02 and APR-03. The stream reach exhibited optimal substrate and instream habitat characteristics (e.g. non-embedded gravel/cobbles, snags and woody debris) for the maintenance of the benthic macroinvertebrate community. Pool substrate was comprised largely of firm sand/gravel and the majority of the pools within the reach were large and deep. Observed sediment deposition was minimal throughout the site. The channel flow status was optimal with water reaching the base of both banks and sinuosity was marginal. The stream was in its natural state with no recent or apparent alterations. Both banks were stable and well vegetated with only sparse areas of erosion noted. Riparian areas were undisturbed.

Water Quality:

Total ammonia (0.02 mg/L as N) and nitrate+nitrite (0.02 mg/L as N) levels were low indicating minimal nitrogen enrichment. Both dissolved (0.07 mg/L as P) and total (0.09 mg/L as P) were slightly elevated. All other chemistries sampled were reflective of excellent water quality.

Direct Drainages to the James River

The following pages summarize the findings during 2012 at six newly established sites that flow directly to the James River. Photos depict the upstream view of the site unless otherwise noted. Left and right banks are referenced from the perspective looking upstream.

Site Number JR-04

Stream: Spring Creek

Site: Downstream of Old Gun Road E.

Watershed: James River

Subwatershed: Spring Creek

Approximate Drainage Area (acres): 847

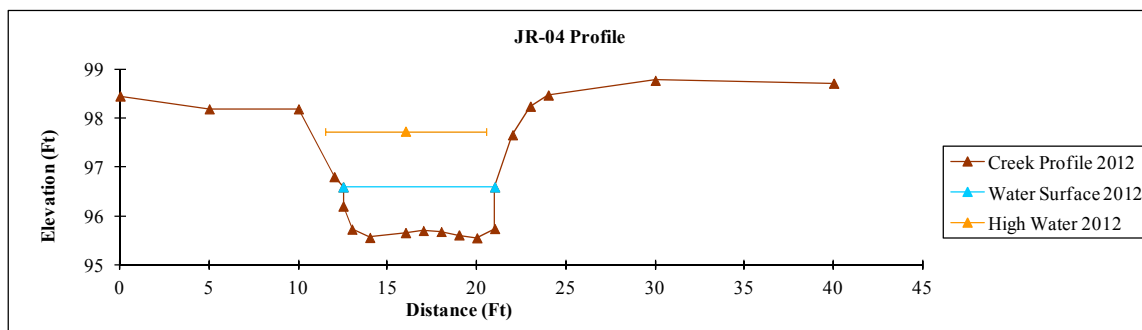
Stream Order: 2

Ecoregion: Low River Terrace and Alluvium (7)

Land use: Residential, Forest



Stream Hydrologic Profile:



Bioassessment:

The bioassessment in 2012 indicated a “Moderately Impaired” status. Although total taxa richness (n=26) was good, EPT taxa richness (n=5) was low indicating a scarcity of these indicator organisms. Midge larvae (*Chironomidae*; n=1184) accounted for 51.7% of the organisms recovered resulting in a moderate score for the percent dominant taxa metric. The Hilsenhoff Biotic Index score was high (6.0) demonstrating a community comprised largely of pollution tolerant organisms. The large quantity of midge larvae combined with numerous scuds (*Gammarus*; n=736) present contributed substantially to the high proportion of collector/gatherers represented in the sample (90.0%). Moderate proportions of predator (4.0%) and scraper (1.1%) taxa were observed. Other taxa present in notable numbers included segmented worms (*Oligochaetes*), *Corbicula* clams and biting midges (*Bezzia*).

Habitat Assessment:

The habitat assessment score at this site was the second lowest observed among all values in 2012 and indicated a “Non-Supporting” condition for the reach. The streambed was comprised largely of muck with the epifaunal substrate metric returning a marginal value. Pool substrate was largely mud and the reach contained a preponderance of large deep pools. Fine sediment deposition was prevalent throughout the site’s length. The channel flow status was optimal. The reach appeared to show evidence of historic channelization and as a result lacked strong sinuosity. Both stream banks exhibited obvious areas of scour/erosion and were sparsely vegetated. The riparian areas on either side were a combination of old and active agricultural fields (hay).

Water Quality:

The concentration of nitrate+nitrite nitrogen (0.35 mg/L as N) was slightly elevated suggesting an upstream source of nitrogen enrichment. All other chemistries sampled were reflective of excellent water quality.

Site Number JR-05

Stream: Tributary to the James

Site: Downstream of Ashwell Drive

Watershed: James River

Subwatershed: James River (4)

Approximate Drainage Area (acres):
152

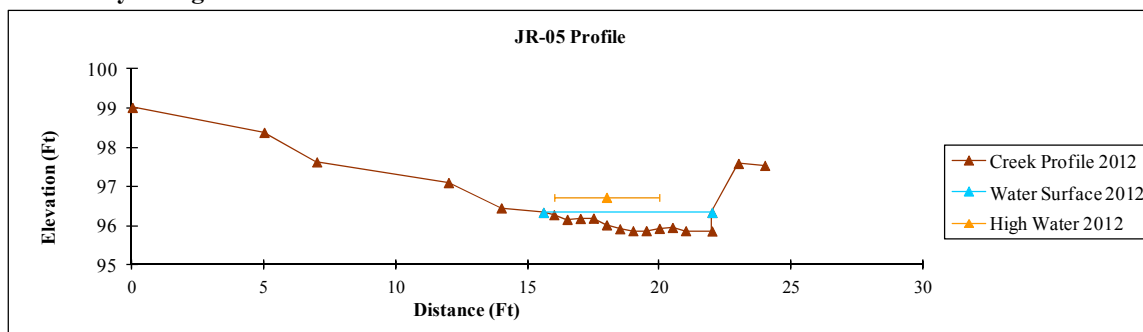
Stream Order: 1

Ecoregion: Low River Terrace and
Alluvium (7)

Land use: Residential



Stream Hydrologic Profile:



Bioassessment:

The bioassessment in 2012 indicated a “Severely Impaired status. Total taxa richness (n=11) and EPT taxa richness (n=1) were low with 87.9 percent of the sample comprised of midge larvae (*Chironomidae*; n=581). Total taxa richness at this reach was the lowest observed among all sites in 2012. The Hilsenhoff Biotic Index score was high (6.1) indicating a community comprised largely of pollution tolerant organisms. The large quantity of midge larvae observed contributed substantially to the high proportion of collector/gatherers represented in the sample (92.3%). The proportion of predator taxa present in the sample (0.5%) was the lowest percentage observed among all sites in 2012. The percentage of scraper taxa (5.4%) noted was the greatest among all sites in 2012 due to numbers of lunged snails (*Physella*) observed. Other taxa present in notable numbers included segmented worms (*Oligochaetes*).

Habitat Assessment:

The habitat assessment in 2012 indicated a “Partially Supporting” condition. The stream reach exhibited suitable substrate and instream habitat characteristics for the maintenance of the benthic macroinvertebrate community with gravel, cobble and exposed bedrock/boulders present. Pool substrate was comprised largely of firm sand/gravel and pool variability was suboptimal. Observed sediment deposition was minimal throughout the site. The channel flow status was optimal with water reaching the base of both banks and sinuosity was excellent. The stream was in its natural state with no recent or apparent alterations aside from a recent upstream crossing. Both stream banks exhibited obvious areas of heavy scour/erosion and as a result were sparsely vegetated. A sanitary easement along the left bank and yards/homes along the right bank decreased the depth of the riparian buffer areas.

Water Quality:

The calcium hardness value (53.7 mg CaCO₃) was among the greatest observed at all sites and indicated soft water. Nutrient levels as measured by nitrogen and phosphorus species were low (≤ 0.05 mg/L as N or P) suggesting minimal enrichment. The observed *E. coli* density (261.3 MPN/100ml) was in excess of the Virginia DEQ water quality standard for contact recreation. All other chemistries sampled were reflective of excellent water quality.

Site Number JR-06

Stream: Tributary to the James

Site: East of James River Road Drive

Watershed: James River

Subwatershed: James River (4)

Approximate Drainage Area (acres): 306

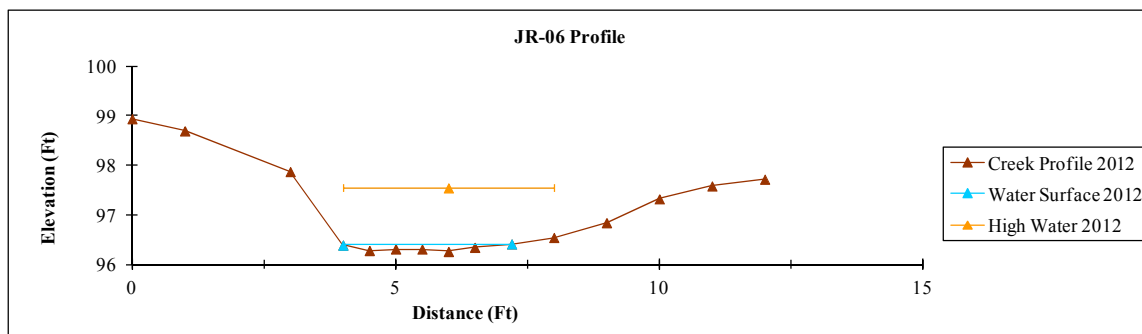
Stream Order: 2

Ecoregion: Low River Terrace and Alluvium (7)



Land use: Robious Landing Park, Residential

Stream Hydrologic Profile:



Bioassessment:

In 2012, the bioassessment score at this reach was the lowest among all sites (20.0%) and indicated a “Severely Impaired” condition. Total taxa richness (n=16) and EPT taxa richness (n=1) were among the lowest observed in 2012. High numbers of midge larvae (*Chironomidae*; n=1970) resulted in the greatest percent dominant taxa (92.7%) noted among all assessed sites. The Hilsenhoff Biotic Index score was high (6.0) indicating a community comprised largely of pollution tolerant organisms. The large quantity of midge larvae observed in addition to numbers of segmented worms (*Oligochaetes*; n=91) contributed substantially to the highest proportion of collector/gatherers represented among all sites (97.8%). The percentages of predator (1.5%) and scraper (0.2%) were poor. Other taxa recovered included biting midges (*Bezzia*) and crayfish (*Cambarus*).

Habitat Assessment:

The habitat assessment in 2012 indicated a “Supporting” condition. The stream reach exhibited optimal substrate and instream habitat characteristics (e.g. non-embedded gravel/cobbles, snags and woody debris) for the maintenance of the benthic macroinvertebrate community. Pool substrate was comprised largely of firm sand/gravel and the majority of the pools within the reach were large and deep. Observed sediment deposition was minimal throughout the site. The channel flow status was optimal with water reaching the base of both banks and sinuosity was excellent. The stream was in its natural state with no recent or apparent alterations. Both stream banks exhibited obvious areas of heavy scour and erosion and as a result were sparsely vegetated. Riparian areas were largely undisturbed.

Water Quality:

Dissolved (0.02 mg/L as P) and total (0.03 mg/L as P) phosphorus concentrations were the lowest observed among all sites in 2012. Fecal coliform (≥ 1600 MPN/100ml) and *E. coli* (686.7 MPN/100ml) densities were the greatest observed in 2012 and indicated a substantial sanitary sewage influence on this stream system. All other chemistries sampled were reflective of excellent water quality.

Site Number JR-07

Stream: Tributary to the James

Site: West of James River Road Drive

Watershed: James River

Subwatershed: James River (4)

Approximate Drainage Area (acres):
137

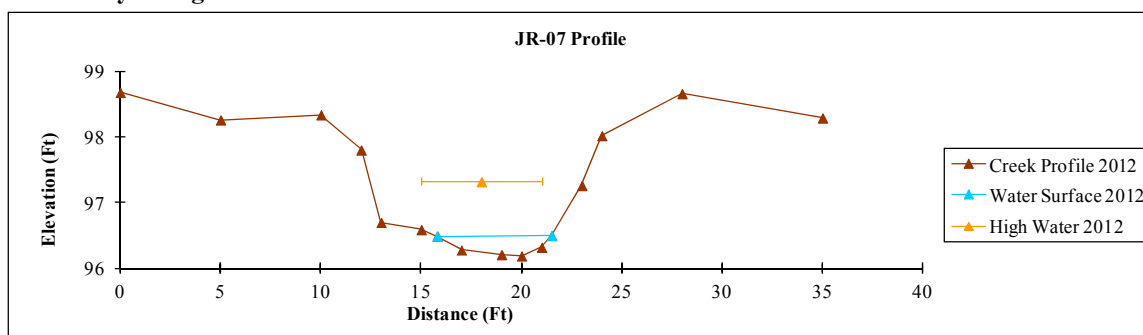
Stream Order: 1

Ecoregion: Low River Terrace and Alluvium (7)



Land use: Robious Landing Park, Schools

Stream Hydrologic Profile:



Bioassessment:

The bioassessment in 2012 indicated a “Severely Impaired status. Total taxa richness (n=14) and EPT taxa richness (n=2) were low with 82.3 percent of the sample comprised of midge larvae (*Chironomidae*; n=1387). The Hilsenhoff Biotic Index score was high (6.1) indicating a community comprised largely of pollution tolerant organisms. The large quantity of midge larvae observed in combination with numbers of scuds (*Gammarus*; n=140) and segmented worms (*Oligochaetes*; n=28) resulted in a high proportion of collector/gatherers presented in the sample (92.7%). The proportion of predator taxa present in the sample (6.8%) was moderate due to the presence of the predaceous diving beetle *Hydroporus*. Scraper taxa were poorly represented with the proportion observed (0.1%) the lowest among all sites in 2012. Other taxa present in notable numbers included biting midge larvae (*Bezzia*).

Habitat Assessment:

The habitat assessment in 2012 indicated a “Supporting” condition. The stream reach exhibited optimal substrate and instream habitat characteristics (*e.g.* non-embedded gravel/cobbles, snags and woody debris) for the maintenance of the benthic macroinvertebrate community. Pool substrate was comprised largely of mixed materials (firm sand/gravel/cobbles) and the majority of the pools within the reach were shallow. Observed sediment deposition was minimal throughout the site. The channel flow status was optimal with water reaching the base of both banks and sinuosity was generally lacking. The stream was in its natural state with no recent or apparent alterations. Both banks were stable and well vegetated with only sparse areas of erosion and scour noted. Riparian areas were undisturbed.

Water Quality:

The calcium hardness value (53.7 mg CaCO₃) was among the greatest observed in 2012 and indicated soft water. Total ammonia (0.06 mg/L as N) and nitrate+nitrite (0.07 mg/L as N) nitrogen levels were slightly elevated. Concentrations of dissolved (0.03 mg/L as P) and total (0.03 mg/L as P) phosphorus were low. The level of total suspended solids (<1.0 mg/L) was the lowest observed in 2012. All other chemistries sampled were reflective of excellent water quality.

Site Number JR-08

Stream: Marine Spring Branch

Site: Downstream of Kings Farm Drive

Watershed: James River

Subwatershed: Marine Spring Branch

Approximate Drainage Area (acres): 265

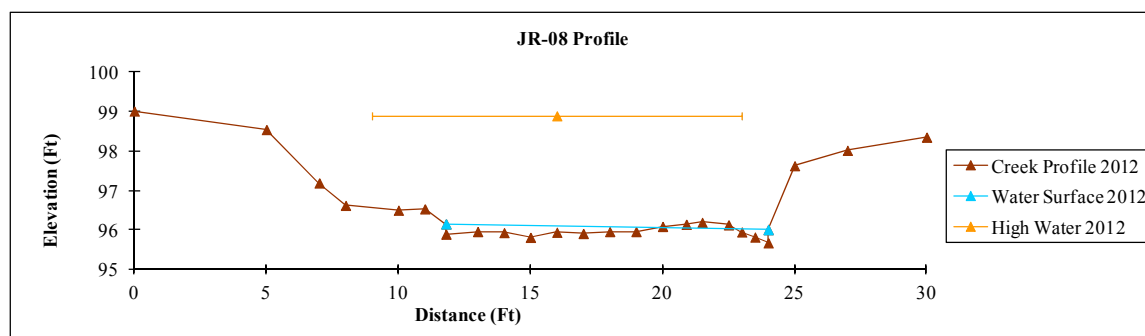
Stream Order: 2

Ecoregion: Triassic Basin (2)

Land use: Residential



Stream Hydrologic Profile:



Bioassessment:

The bioassessment in 2012 indicated a “Moderately Impaired” status. Total taxa richness (n=30) and EPT taxa richness (n=11) values were both solid with midge larvae (*Chironomidae*; n=732) accounting for 67.7% of the organisms recovered. The Hilsenhoff Biotic Index score was moderate (5.8) demonstrating a community comprised of a mix of both pollution tolerant and pollution sensitive organisms. While the proportion of collector/gatherers represented in the sample (79.9%) was high, it returned an acceptable moderate score for that metric. Moderate proportions of predator (6.7%) and scraper (3.0%) taxa were also observed. Other taxa present in notable numbers included scuds (*Crangonyx*), segmented worms (*Oligochaetes*) and *Haploperla* stonefly larvae.

Habitat Assessment:

The habitat assessment in 2012 indicated a “Partially Supporting” condition. The stream reach exhibited suitable substrate and instream habitat characteristics for the maintenance of the benthic macroinvertebrate community with firm sand, gravel and cobble present. Pool substrate was comprised largely of an optimal mixture of bed materials and pool variability was excellent. Observed sediment deposition was minimal throughout the site. The channel flow status was optimal with water reaching the base of both banks and sinuosity was excellent. The stream was in its natural state with no recent or apparent alterations aside from the upstream road crossing. Both stream banks exhibited obvious areas of heavy scour and erosion and as a result were sparsely vegetated. The riparian area depth along the right bank was decreased due to existing yards and homes.

Water Quality:

The concentration of nitrate+nitrite (0.80 mg/L as N) was the greatest value observed among all sites in 2012 and reflected a substantial source of upstream nitrogen enrichment. The concentrations of dissolved (0.03 mg/l as P) and total (0.04 mg/L as P) phosphorus were low. All other chemistries were reflective of excellent water quality.

Site Number JR-09

Stream: Roberts Branch

Site: Upstream of Crossings Way

Watershed: James River

Subwatershed: Roberts Branch

Approximate Drainage Area (acres):
254

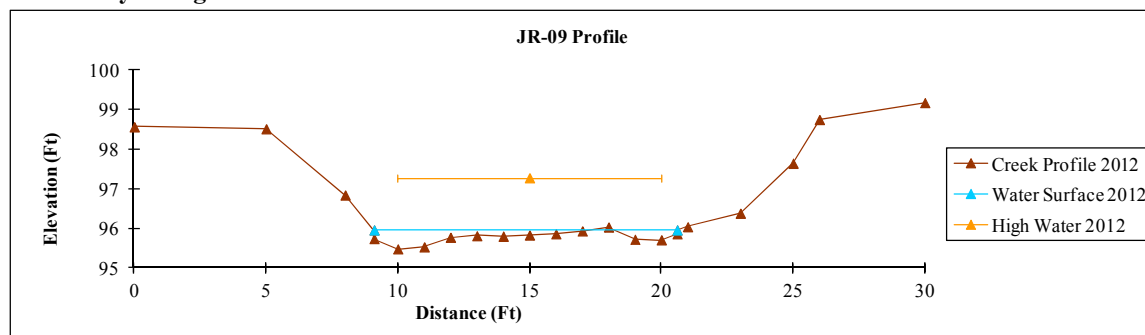
Stream Order: 2

Ecoregion: Triassic Basin (2)

Land use: Residential, Forest



Stream Hydrologic Profile:



Bioassessment:

The bioassessment in 2012 indicated a “Moderately Impaired” status. Total taxa richness (n=23) and EPT taxa richness (n=8) values were both acceptable with midge larvae (*Chironomidae*; n=993) accounting for 76.0% of the organisms recovered. The Hilsenhoff Biotic Index score was moderate (5.8) demonstrating a community comprised of a mix of both pollution tolerant and pollution sensitive organisms. The large quantity of midge larvae observed in combination with numbers of *Acentrella* mayfly larvae (n=94) and segmented worms (*Oligochaetes*; n=56) resulted in a high proportion of collector/gatherers present in the sample (91.0%). Moderate proportions of predator (4.1%) and scraper (0.8%) taxa were also observed. Other taxa present in notable numbers included scuds (*Crangonyx*), biting midge larvae (*Bezzia*) and blackfly larvae (*Simulium*).

Habitat Assessment:

The habitat assessment in 2012 indicated a “Partially Supporting” condition. With a few exceptions, the overall reach habitat characteristics were very similar to site JR-08. The stream reach exhibited suitable substrate and instream habitat characteristics for the maintenance of the benthic macroinvertebrate community with firm sand, gravel and cobble present. Pool substrate was comprised largely of an optimal mixture of bed materials and pool variability was excellent. Observed sediment deposition was minimal throughout the site. The channel flow status was optimal with water reaching the base of both banks and sinuosity was adequate. The stream was in its natural state with no recent or apparent alterations. Both stream banks exhibited obvious areas of scour and erosion and as a result were poorly vegetated. The riparian area depth along the left bank was decreased due to existing homes.

Water Quality:

The concentration of nitrate+nitrite (0.75 mg/L as N) was the second greatest value observed among all sites in 2012 and reflected a substantial source of upstream nitrogen enrichment. The concentrations of dissolved (0.03 mg/l as P) and total (0.04 mg/L as P) phosphorus were low. All other chemistries were reflective of excellent water quality.

Michaux Creek Watershed

The following pages summarize the findings during 2012 at five newly established sites in the Michaux Creek Watershed. Photos depict the upstream view of the site unless otherwise noted. Left and right banks are referenced from the perspective looking upstream.

Site Number MCX-01

Stream: Michaux Creek

Site: East of Route 288

Watershed: James River

Subwatershed: Michaux Creek

Approximate Drainage Area (acres):
18

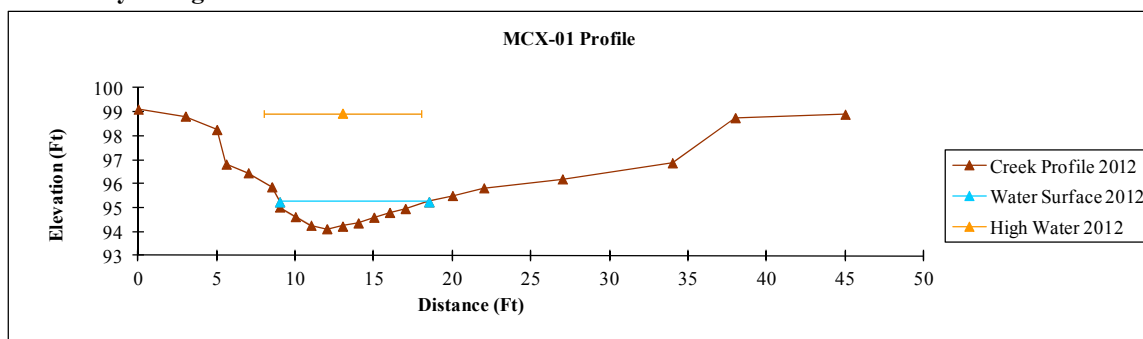
Stream Order: 3

Ecoregion: Triassic Basin (2)

Land use: Residential, Forest,
Commercial



Stream Hydrologic Profile:



Bioassessment:

The bioassessment in 2012 indicated a “Moderately Impaired” status. Total taxa richness (n=25) and EPT taxa richness (n=6) values were both acceptable with midge larvae (*Chironomidae*; n=267) accounting for 66.6% of the organisms recovered. The Hilsenhoff Biotic Index score was moderate (5.4) demonstrating a community comprised of a mix of both pollution tolerant and pollution sensitive organisms. The quantity of midge larvae observed in combination with numbers of *Ephemera* (n=28) and *Acentrella* (n=20) mayfly larvae and segmented worms (*Oligochaetes*; n=20) resulted in a high proportion of collector/gatherers present in the sample (84.0%). Moderate proportions of predator (3.5%) and scraper (3.5%) taxa were also observed. Other taxa present in notable numbers included blackfly larvae (*Simulium*).

Habitat Assessment:

The habitat assessment in 2012 indicated a “Supporting” condition. The stream reach exhibited optimal substrate and instream habitat characteristics (e.g. non-embedded gravel/cobbles, snags and woody debris) for the maintenance of the benthic macroinvertebrate community. Pool substrate was comprised largely of an optimal mixture of bed materials and pool variability was excellent. There was a slight degree of increased sediment deposition throughout the site. The channel flow status was optimal with water reaching the base of both banks and sinuosity was excellent. The stream was in its natural state with no recent or apparent alterations. Both stream banks exhibited obvious areas of heavy scour/erosion and as a result were sparsely vegetated. Riparian areas were completely undisturbed.

Water Quality:

The concentrations of total ammonia (0.12 mg/L as N) and nitrate+nitrite (0.12 mg/L as N) were slightly elevated suggesting a diluted source of upstream nitrogen input. The concentration of total phosphorus (0.06 mg/L as P) was likewise slightly elevated. The level of total suspended solids (<1.0 mg/L) was tied for the lowest observed in 2012. All other chemistries were reflective of excellent water quality.

Site Number MCX-02

Stream: Tributary to Michaux Creek

Site: East of Route 288 & Upstream of MCX-01

Watershed: James River

Subwatershed: Michaux Creek

Approximate Drainage Area (acres):
124

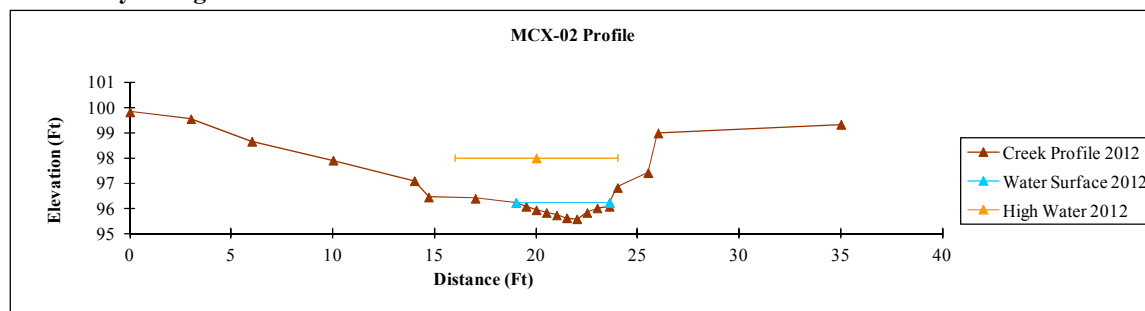
Stream Order: 1

Ecoregion: Triassic Basin (2)

Land use: Forest



Stream Hydrologic Profile:



Bioassessment:

In 2012, the bioassessment score (82.9%) was tied for the greatest observed among all sites and reflected a “Non-Impaired” condition. Total taxa richness (n=33) was excellent and EPT taxa richness (n=15) was tied for the highest value observed among all sites. The community composition was well balanced with only 39.0% of the sample comprised of a single animal (*Ephemerella*; n=366). The Hilsenhoff Biotic Index value was the best observed in 2012 (3.2) and reflected a community comprised almost exclusively of pollution sensitive taxa. The proportion of collector/gatherers was moderate (63.8%). The percentage of predator taxa (15.7%) was the highest observed among all sites due to strong numbers of *Haploperla* (n=77) and *Isoperla* (n=22) stonefly larvae. Scraper organisms were represented in moderate proportions (1.9%). All metrics were suggestive of a fully functional and strong benthic community. Among other macroinvertebrates well represented were *Amphinemura* stonefly larvae, midge larvae (*Chironomidae*) and *Acentrella* mayfly nymphs.

Habitat Assessment:

The habitat assessment in 2012 indicated a “Supporting” condition. The stream reach exhibited optimal substrate and instream habitat characteristics (e.g. non-embedded gravel/cobbles, snags and woody debris) for the maintenance of the benthic macroinvertebrate community. Pool substrate was comprised largely of a suboptimal mixture sand/gravel and the majority of the pools within the reach were large and deep. There was a moderate degree of increased sediment deposition throughout the site. The channel flow status was optimal with water reaching the base of both banks and sinuosity was excellent. The stream was in its natural state with no recent or apparent alterations. Both banks were stable and well vegetated with only sparse areas of erosion noted. Riparian areas were completely undisturbed.

Water Quality:

The concentrations of nitrate+nitrite nitrogen (0.17 mg/L as N) and total phosphorus (0.06 mg/L as P) phosphorus were slightly elevated in 2012. All other chemistries sampled indicated excellent water quality.

Site Number MCX-03

Stream: Tributary to Michaux Creek

Site: Southwest of North Otterdale Road

Watershed: James River

Subwatershed: Michaux Creek

Approximate Drainage Area (acres):
46

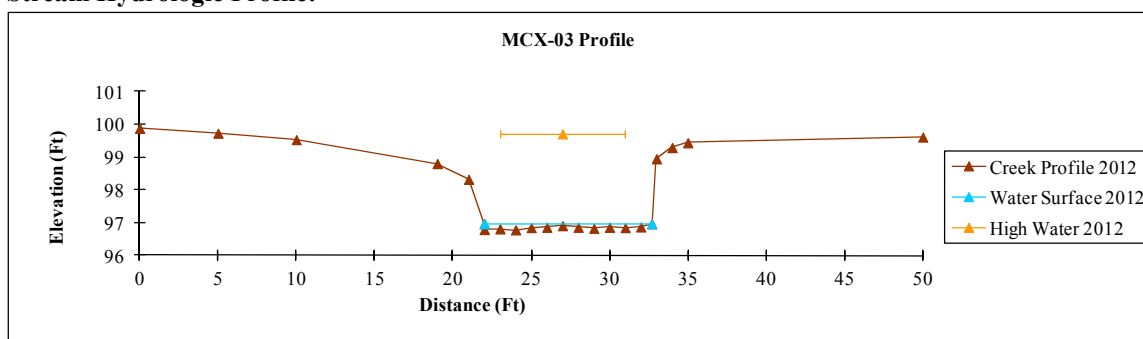
Stream Order: 1

Ecoregion: Triassic Basin (2)

Land use: Commercial, Forest



Stream Hydrologic Profile:



Bioassessment:

The bioassessment in 2012 indicated a “Severely Impaired” status. Total taxa richness (n=18) and EPT taxa richness (n=2) were low with 79.6 percent of the sample comprised of midge larvae (*Chironomidae*; n=555). The Hilsenhoff Biotic Index score was the greatest observed in 2012 (6.2) and indicated a community comprised largely of pollution tolerant organisms. The large quantity of midge larvae observed contributed substantially to the high proportion of collector/gatherers represented in the sample (81.1%). The proportion of predator taxa present in the sample (12.5%) was excellent due to a strong quantity of *Enallagma* damselfly and biting midge (*Bezzia*) larvae recovered. Scraper taxa (3.2%) were represented in moderate proportions in 2012. Other taxa present in notable numbers included riffle beetles (*Stenelmis*) and net-spinner caddisfly larvae (*Cheumatopsyche*).

Habitat Assessment:

The habitat assessment in 2012 indicated a “Supporting” condition. With a few exceptions, the overall reach habitat characteristics were very similar to sites MCX-01 and MCX-02. The stream reach exhibited borderline optimal/suboptimal substrate and instream habitat characteristics (e.g. non-embedded gravel/cobbles, snags and woody debris) for the maintenance of the benthic macroinvertebrate community. Pool substrate was comprised largely of a suboptimal mixture sand/gravel and the majority of the pools within the reach were large and deep. There was a moderate degree of increased sediment deposition present throughout the site. The channel flow status was optimal with water reaching the base of both banks and sinuosity was excellent. The stream was in its natural state with no recent or apparent alterations. Both banks were stable and well vegetated with only sparse areas of erosion noted. Riparian areas were completely undisturbed.

Water Quality:

The greatest conductivity measurement (199 $\mu\text{S}/\text{cm}$) observed in 2012 was recorded at this site. The concentrations of nitrate+nitrite nitrogen (0.35 mg/L as N), dissolved phosphorus (0.06 mg/L as P) and total phosphorus (0.09 mg/L as P) were slightly elevated in 2012. All other chemistries sampled indicated excellent water quality.

Site Number MCX-04

Stream: Tributary to Michaux Creek

Site: Downstream of Lastingham Drive

Watershed: James River

Subwatershed: Michaux Creek

Approximate Drainage Area (acres):
481

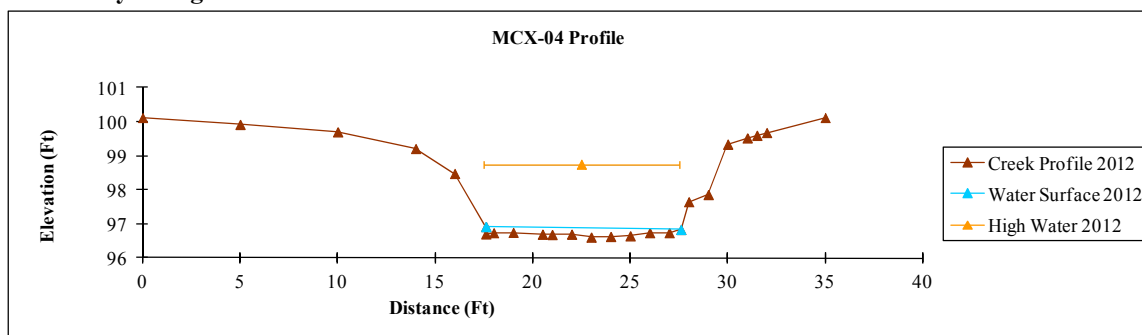
Stream Order: 2

Ecoregion: Triassic Basin (2)

Land use: Residential, Forest



Stream Hydrologic Profile:



Bioassessment:

The bioassessment in 2012 indicated a “Severely Impaired” status. Total taxa richness (n=18) and EPT taxa richness (n=3) were low with 74.4 percent of the sample comprised of midge larvae (*Chironomidae*; n=258). The Hilsenhoff Biotic Index score was moderate (5.8) demonstrating a community comprised of a mix of both pollution tolerant and pollution sensitive organisms. The large quantity of midge larvae observed in combination with numbers of segmented worms (*Oligochaetes*; n=32) resulted in a high proportion of collector/gatherers present in the sample (85.9%). Moderate proportions of predator (4.0%) and scraper (1.2%) taxa were also observed. Among other macroinvertebrates well represented were net-spinner caddisfly larvae (*Hydropsyche*) and *Haploperla* stonefly larvae.

Habitat Assessment:

The habitat assessment in 2012 indicated a “Partially Supporting” condition. The stream reach exhibited suboptimal substrate and instream habitat characteristics for the maintenance of the benthic macroinvertebrate community with firm sand/gravel and cobble present along the length. Pool substrate was comprised largely of a suboptimal mixture of sand/gravel and the majority of the pools within the reach were large and deep. Observed sediment deposition was minimal throughout the site. The channel flow status was optimal with water reaching the base of both banks. The reach exhibited historic channelization and as a result lacked strong sinuosity. The stream was in its natural state with no recently apparent alterations aside from the upstream road crossing. Both stream banks exhibited obvious areas of scour/erosion and as a result were sparsely vegetated. The riparian area depth along the right bank was decreased due to an existing sanitary sewer easement.

Water Quality:

The concentration of total ammonia nitrogen (<0.01 mg/L as N) was the lowest observed among all sites in 2012. Conversely, the concentration of nitrate+nitrite (0.69 mg/L as N) was among the greatest values observed in 2012 and reflected a substantial source of upstream nitrogen enrichment. All other chemistries were reflective of excellent water quality.

Site Number MCX-05

Stream: Michaux Creek

Site: End of North Otterdale Road

Watershed: James River

Subwatershed: Michaux Creek

Approximate Drainage Area (acres):
1069

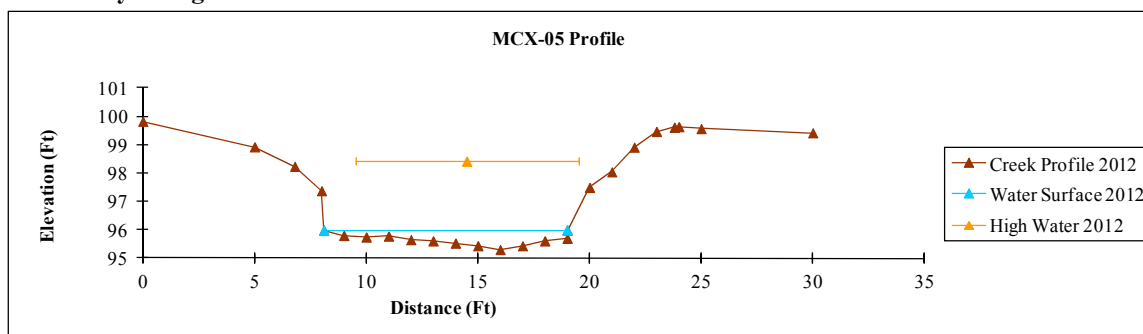
Stream Order: 3

Ecoregion: Triassic Basin (2)

Land use: Residential, Forest,
Commercial



Stream Hydrologic Profile:



Bioassessment:

The bioassessment in 2012 indicated a “Severely Impaired” status. Total taxa richness (n=19) and EPT taxa richness (n=3) were low with 68.7 percent of the sample comprised of midge larvae (*Chironomidae*; n=224). The Hilsenhoff Biotic Index score was high (6.0) indicating a community comprised largely of pollution tolerant organisms. While the proportion of collector/gatherers represented in the sample (78.5%) was high, it returned an acceptable moderate score for that metric. Moderate proportions of predator (8.0%) and scraper (3.1%) taxa were also observed. Other taxa present in notable numbers included segmented worms (*Oligochaetes*) and net-spinner caddisfly larvae (*Hydropsyche*).

Habitat Assessment:

The habitat assessment in 2012 indicated a “Partially Supporting” condition. The stream reach exhibited optimal substrate and instream habitat characteristics for the maintenance of the benthic macroinvertebrate community with firm sand/gravel and cobble present along the length. Pool substrate was comprised largely of a suboptimal mixture of sand/gravel and the majority of the pools within the reach were large and deep. There was a moderate degree of increased sediment deposition present throughout the site. The channel flow status was optimal with water reaching the base of both banks and sinuosity was adequate. The stream was in its natural state with no recently apparent alterations aside from an upstream road crossing. Both stream banks exhibited obvious areas of scour/erosion and as a result were sparsely vegetated. The riparian area depths along both banks were decreased due to the presence of a recent cutover along the left and the construction of a new road along the right.

Water Quality:

The concentrations of nitrate+nitrite nitrogen (0.25 mg/L as N) dissolved phosphorus (0.07 mg/L as P) and total phosphorus (0.18 mg/L as P) were slightly elevated. The greatest concentration of total suspended solids (34.1 mg/L) observed in 2012 was noted at this reach with TSS visibly noticeable in the stream. The greatest concentration of Biological Oxygen Demand was recorded at this site (11.8 mg/L) suggesting a slight source of upstream organic enrichment. All other chemistries were reflective of excellent water quality.

Discussion

Bioassessments:

A total of 19,184 individual benthic macroinvertebrates representing 79 distinct taxa were recovered in 2012. From this data set, the 20 most common taxa were identified and tabulated (Table 9). These 20 taxa combined accounted for approximately 95 percent of all organisms observed during 2012. Twelve taxa were common with those listed in the 2011 report although it should be noted that 2012 represented new previously un-assessed watersheds. These common taxa are presented in bold within Table 9.

Table 9. The twenty most common taxa observed throughout Chesterfield County, 2012

Number	Taxa	Common Name	Feeding Guild	n
1	Chironomidae	Midge Larvae	Collector/Gatherer	11451
2	Gammarus	Scuds	Collector/Gatherer	878
3	Oligochaeta	Segmented Worms	Collector/Gatherer	849
4	<i>Ephemerella</i>	Spiny Crawler Mayfly	Collector/Gatherer	560
5	<i>Amphinemura</i>	Nemourid Stonefly	Shredder	555
6	Crangonyx	Scuds	Collector/Gatherer	534
7	Acentrella	Small Minnow Mayfly	Collector/Gatherer	532
8	Bezzia/palpomyia	Biting Midge Larvae	Predator	531
9	Leptophlebia	Pronggilled Mayfly	Collector/Gatherer	345
10	<i>Haploperla</i>	Green Stonefly	Predator	312
11	Perlesta	Common Stonefly	Omnivore	300
12	Pisidium	Fingernail Clam	Filter/Collector	276
13	Simulium	Blackfly Larvae	Filter/Collector	232
14	Hydroporus	Predaceous Diving Beetle	Predator	203
15	Stenelmis	Riffle Beetle	Scraper	116
16	<i>Physella</i>	Physid Snail	Scraper	109
17	<i>Corbicula</i>	Asian Clam	Filter/Collector	97
18	<i>Ameletus</i>	Ameletid Minnow Mayfly	Collector/Gatherer	94
19	<i>Acerpenna</i>	Small Minnow Mayfly	Shredder	90
20	<i>Leuctra</i>	Rolledwinged Stonefly	Shredder	87

Bold taxa represent those common with 2011 assessments in differing watersheds.

As in previous years, the overwhelming majority of organisms recovered belonged to the *Chironomidae* family of insects although it should be noted that many different genera of midge larvae were observed but not identified. The number of individual midge larvae collected (n=11,451) represented 60% of total individuals observed in 2012. The more pollution sensitive Ephemeroptera/Plecoptera/Trichoptera (EPT) taxa collectively accounted for nine of the twenty most common taxa of benthic macroinvertebrates observed. Overall numbers of these taxa (n=3306) represented 17 percent of all individuals recovered in 2012. The twenty most common taxa reflected a general condition indicative of fair to moderate water quality within these watersheds.

A summary of the bioassessment categories of the monitored watersheds indicated that 80 percent of sites sampled (n=12) scored in the two lower categories during 2012 (Figure 1). Seven sites were classified as “Severely Impaired” and five were assessed as “Moderately Impaired.” One site in the Appomattox River watershed (APR-04) exhibited a “Slightly Impaired” bioassessment condition and two sites (APR-02 and MCX-02) were assessed as “Non-Impaired” in 2012. The overall best bioassessment scores were noted in the Appomattox River watershed where two of the four sites investigated were characterized as either “Slightly Impaired” or “Non-Impaired.”

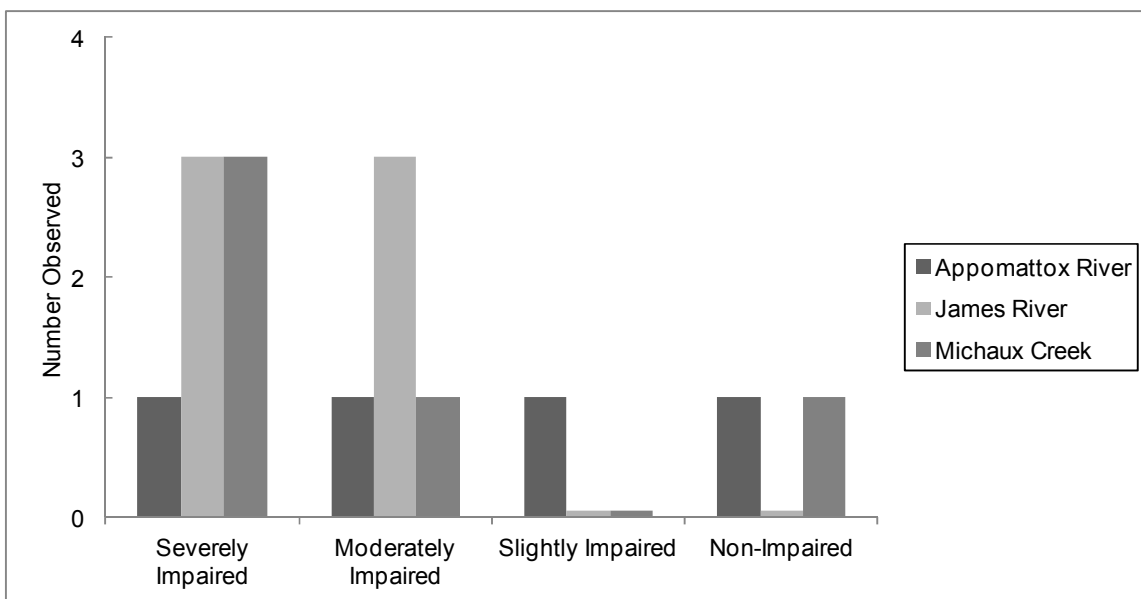


Figure 1. Categorical bioassessment observations in select watershed of Chesterfield County, 2012.

Four sites were investigated at small stream systems draining directly to the Appomattox River with bioassessment observations evenly distributed among each category (Figure 1). Generally, the best bioassessment scores observed in 2012 were noted within this data set with two of the four reaches assessed returning values indicative of a “Slightly Impaired” or “Non-Impaired” status. At these two sites, total taxa and EPT taxa richness values were among the best observed in 2012 indicating a wide variety of organisms. At Stoney Creek (APR-02; “Non-Impaired”), the benthic macroinvertebrate community was not dominated by a single organism and was comprised largely of pollution sensitive taxa. A greater proportion of pollution tolerant taxa were observed at Cattle Creek (APR-04; “Slightly Impaired”) contributing to the slightly lower assessment at this site. Both Stoney Creek and Cattle Creek had moderate or excellent percentages of collector/gatherer, predator and scraper taxa indicating a well balanced and functional benthic community.

The remaining two sites scored in the “Moderately Impaired” and “Severely Impaired” categories. Increased proportions of a single organism as well as a community dominated by collector/gatherer and pollution tolerant taxa were the factors influencing the score at the Tributary to the Appomattox River site (APR-03; “Moderately Impaired”). At Fleets

Branch (APR-01; “Severely Impaired”), a similar community feeding guild structure coupled with low total taxa and EPT taxa richness values were the basis of the stream’s depressed bioassessment score.

Six sites were investigated at stream systems draining directly to the James River with three reaches scoring as “Moderately Impaired” and three as “Severely Impaired” (Figure 1). Within this data set, the better scoring “Moderately Impaired” sites were all larger, named streams and included Spring Creek (JR-04), Marine Spring Branch (JR-08) and Roberts Branch (JR-09). At these sites, total taxa richness was acceptable and tended to score in the moderate category. EPT taxa richness was likewise acceptable with the exception of Spring Creek (JR-04) where the value was low (n=5). The percent dominant taxa and Hilsenhoff Biotic Index metrics varied among sites and were all in the low or moderate category demonstrating high numbers of one organism and a general lack of strong representation of pollution sensitive taxa. Feeding guild analysis indicated communities with high proportions of collector/gatherer organisms and moderate percentages of predator and scraper taxa.

The remaining three reaches assessed within this data set were all un-named Tributaries to the James River (JR-05, JR-06 and JR-07) and scored in the “Severely Impaired” category. Common characteristics at these sites included low total taxa and EPT taxa richness values and high proportions of midge larvae (*Chironomidae*) present in the sample. Hilsenhoff Biotic Index values were all high indicating a predominance of pollution tolerant taxa. Feeding guild analysis typically demonstrated a large proportion of collector/gatherer organisms and a general lack of predator and scraper taxa. The exception to this was observed at JR-05 where the proportion of scraper taxa was the highest observed among all sites, due primarily to a number of the pollution tolerant lunged snails (*Physella*) recovered in the sample.

Five sites were assessed in the Michaux Creek watershed with one reach scoring as “Non-Impaired” and the remaining four scoring in either the “Moderately Impaired” or “Severely Impaired” categories (Figure 1). One of the best bioassessment values observed in 2012 was noted at an un-named Tributary to Michaux Creek (MCX-02; 82.9%). At this site, total taxa and EPT taxa richness values were excellent and among the highest observed among all assessed reaches with no one organism dominating the sample. Collectively, the Hilsenhoff Biotic Index and all feeding guild metrics demonstrated a well-balanced benthic macroinvertebrate community structure comprised of a variety of pollution sensitive organisms.

A lower score with an associated “Moderately Impaired” status was noted at the lowermost Michaux Creek mainstem site (MCX-01). The total taxa and EPT taxa richness values were acceptable and scored in the moderate range along with the Hilsenhoff Biotic Index which indicated a mix of pollution tolerant and pollution sensitive organisms. High proportions of midge larvae (*Chironomidae*; 66.6%) influenced the percent dominant taxa metric negatively and this in conjunction with a variety of other collector/gatherer organisms resulted in a high representation of this

feeding guild within the sample. Predator and scraper taxa were present in moderate numbers.

The remaining three sites all returned bioassessment values indicative of “Severely Impaired” conditions. Two of these reaches were un-named Tributaries to Michaux Creek (MCX-03 and MCX-04) and one was the uppermost assessed site on the Michaux Creek mainstem (MCX-05). As with the other “Severely Impaired sites previously discussed, common characteristics at these reaches included low total taxa and EPT taxa richness values and high proportions of midge larvae (*Chironomidae*) present in the sample. The Hilsenhoff Biotic Index values were typically high at these reaches indicating a general lack of pollution sensitive taxa. With the exception of a moderate score at Michaux Creek (MCX-05), the proportion of collector/gatherer organisms were also high among these sites. Despite the “Severely Impaired” conditions, representation by predator and scraper taxa within the benthic macroinvertebrate community at these three sites in 2012 was generally acceptable with an excellent proportion of predator taxa observed at the Tributary to Michaux Creek (MCX-03).

Table 10. Individual site comparisons of Chesterfield County bioassessment categories and the VSCI Aquatic Life Use Tiers, 2012.

Site Number	Stream	Chesterfield County Bioassessment Category	Virginia Stream Condition Index “Aquatic Life Use Tier”	Comparison
APR-01	Fleets Branch	Severely Impaired	Severe Stress	Similar
APR-02	Stoney Creek	Non- Impaired	Excellent	Similar
APR-03	Trib to the Appomattox	Moderately Impaired	Stress	Similar
APR-04	Cattle Creek	Slightly Impaired	Stress	VSCI Lower
JR-04	Spring Creek	Moderately Impaired	Severe Stress	VSCI Lower
JR-05	Trib to the James River	Severely Impaired	Severe Stress	Similar
JR-06	Trib to the James River	Severely Impaired	Severe Stress	Similar
JR-07	Trib to the James River	Severely Impaired	Severe Stress	Similar
JR-08	Marine Spring Branch	Moderately Impaired	Stress	Similar
JR-09	Roberts Branch	Moderately Impaired	Severe Stress	VSCI Lower
MCX-01	Michaux Creek	Moderately Impaired	Severe Stress	VSCI Lower
MCX-02	Trib to Michaux Creek	Non- Impaired	Excellent	Similar
MCX-03	Trib to Michaux Creek	Severely Impaired	Severe Stress	Similar
MCX-04	Trib to Michaux Creek	Severely Impaired	Severe Stress	Similar
MCX-05	Michaux Creek	Severely Impaired	Severe Stress	Similar

The benthic macroinvertebrate data set collected in 2012 was once again analyzed using the stream condition index methodology developed by Tetra Tech, Inc for upland (non-coastal) streams in Virginia. This Virginia Stream Condition Index (VSCI) was developed and tested with a comprehensive statewide data set and has been described as “a primary indicator of ecosystem health” that can “identify impairment with respect to the reference or natural condition” (Tetra Tech 2003). Further validation of this index was accomplished in 2006 using a probabilistic approach involving a database inclusive of 350 stations within the state (VADEQ 2006). Based upon these results, four “Aquatic

Life Use Tiers” were derived, each corresponding to a range of values and degree of impairment (Severe Stress, Stress, Good and Excellent).

Site comparisons were made using the VSCI score derived “Aquatic Life Use Tiers” and the Chesterfield County bioassessment conditions. During 2012, eleven sites exhibited conditions where the VSCI and Chesterfield County bioassessment categories were similar (73%) and four (27%) where the resulting VSCI condition was lower (Table 10). A Pearson’s Correlation was used to determine the strength of the relationship between the Chesterfield County Bioassessment Score and the VSCI score within the newly assessed stream dataset. Analysis of 15 observations indicated that there was a statistically significant ($p < 0.0001$) and strong ($r = 0.98$) positive correlation between these two methods. This result further supports the argument that both approaches yield similar results in the determination of benthic macroinvertebrate stream condition in Chesterfield County. Continued evaluations of both methods will be conducted with the goal of eventually transitioning to using the VSCI exclusively for direct comparison to state programs.

Habitat

A summary of the habitat categories of each monitored watershed indicated that the majority of sites (eight) assessed scored as “Supporting” in 2012 (Figure 2). Five sites were assessed as “Partially Supporting” and two demonstrated a “Non-Supporting” condition. There were no reaches investigated in 2012 that scored a value indicating a “Comparable to Reference” status.

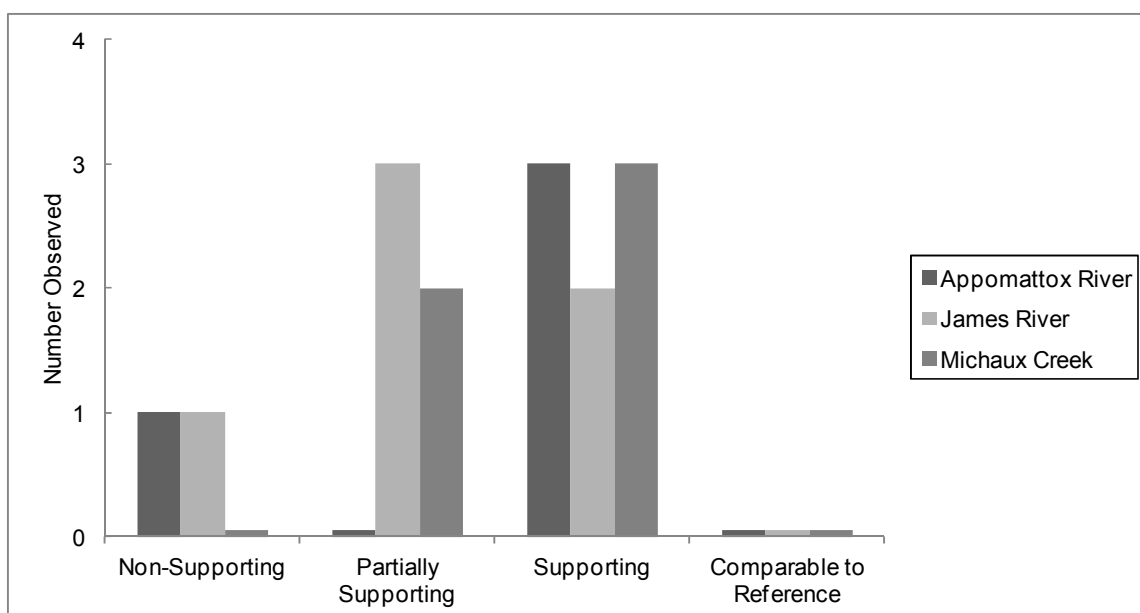


Figure 2. Categorical habitat assessments in select watersheds of Chesterfield County, 2012.

During 2012, three of the four reaches assessed in the streams draining directly to the Appomattox River indicated a “Supporting” habitat condition (Figure 2). These three

streams, Stoney Creek (APR-02), Tributary to the Appomattox (APR-03) and Cattle Creek (APR-04) exhibited similar habitat characteristics, due in part to their location in relatively undeveloped forested areas. Optimal substrate and instream habitat in the form of non-embedded gravel/cobbles, snags and woody debris was prevalent in each of these streams, allowing for full colonization by the benthic macroinvertebrate community. Pools lacked significant sedimentation and were generally large and deep. Sediment deposition varied from minimal to moderate and flow within the stream reaches was excellent. These three streams were in their natural state, exhibiting varying degrees of sinuosity with no visibly recent alterations save for upstream road crossings present. Stream banks appeared stable and were well vegetated. Riparian areas were fully forested and undisturbed. The remaining reach assessed in this data set was located along Fleets Branch (APR-01) and bisected the Virginia State University campus. The habitat assessment score at this site was the lowest observed in 2012 and indicated a “Non-Supporting” status. While instream substrate and habitat was sub-optimal, consisting of cobbles and gravel, pools were relatively shallow and filled with soft sediment. Sedimentation was noticeable throughout the site. The reach exhibited historic channelization and lacked sinuosity. The stream was deeply incised in places with frequent areas of erosion and scour readily visible. As a result, the banks were sparsely vegetated. Both riparian areas were comprised of parking lots and academic buildings and a buffer replanting project was present along the right bank.

During 2012, two of the six reaches assessed in the streams draining directly to the James River indicated a “Supporting” habitat condition, three indicated a “Partially Supporting” status and one was determined to be “Non-Supporting” (Figure 2). Both sites that exhibited “Supporting” habitat were located within the confines of the county’s Robious Landing Park. Common traits present at these two sites (Tributaries to the James; JR-06 and JR-07) included optimal substrate and instream habitat, minimal sediment deposition, and excellent stream flow. Additionally, these two streams were in their natural state with fully forested, largely undisturbed riparian areas. “Partially Supporting” conditions were noted at the Tributary to the James (JR-05), Marine Spring Branch (JR-08) and Roberts Branch (JR-09) during 2012. The lower assessment scores noted at these three sites were due primarily to the presence of increased bank scour and erosion, loss of bank stability and decreased vegetative cover and impacts to the riparian areas. These impacts were in the form of homes, yards and sanitary sewer easements decreasing the depth of the riparian zone. As with previously observed sites in this watershed, these three reaches were in their natural state and demonstrated suitable substrate and instream habitat, minimal sediment deposition, and excellent stream flow. At Spring Creek (JR-04), the second lowest habitat assessment value recorded among all reaches in 2012 was observed and indicated a “Non-Supporting” condition. Factors influencing the lower score noted at this site included marginal substrate and instream habitat metric values, fine sediment deposition throughout the site and the presence of historic channelization that functionally eliminated natural sinuosity. Additionally, both stream banks exhibited obvious areas of scour and erosion and were sparsely vegetated. The riparian areas on either side were decreased due to the existence of old and active agricultural fields.

Three reaches in the Michaux Creek watershed exhibited a “Supporting” status and two sites demonstrated a “Partially Supporting” status during 2012 (Figure 2). One mainstem Michaux Creek site (MCX-01) and two un-named Tributaries to Michaux Creek (MCX-02 and MCX-03) reaches scored conditions indicative of “Supporting” habitat. Common characteristics at these three reaches included optimal substrate and instream habitat, strong flow and excellent sinuosity. In addition, stream channels at these sites were in their natural state with no recent or apparent alterations, and banks along both sides of all reaches were stable and well vegetated. Riparian areas were completely forested and undisturbed. Habitat assessments at the remaining two sites, Tributary to Michaux Creek (MCX-04) and the uppermost Michaux Creek mainstem reach (MCX-05) indicated “Partially Supporting” conditions during 2012. Generally, substrate/instream habitat and channel morphology metrics scored well and were similar to the other sites in the watershed. The differences influencing the lower site assessments at these reaches were primarily observations of degraded riparian and bank structure conditions. At both of these sites, widespread stream bank erosion and scour were evident which resulted in poor vegetative cover. Riparian areas along one or both sides were impacted by sanitary sewer easements, cutovers and new road construction.

Chemistry

A comprehensive suite of chemical parameters was collected during 2012. Supplemental screening for *E. coli* densities in the stream reaches continued to allow for comparison to current Virginia Department of Environmental Quality (VEDEQ) water quality standards. Instream measurements of dissolved oxygen, pH, conductivity/total dissolved solids and temperature yielded values that were within Virginia state water quality standards and normally expected ranges for Chesterfield County during 2012. All dissolved oxygen concentrations were indicative of well-oxygenated waters with values ranging from 6.7 to 11.4 mg/L. Measurements of pH ranged from 6.0 to 6.9 units and temperature readings were normal for the season. No observations of conductivity were greater than 500 μ S/cm. Hardness measurements ranged from 9.3 to 53.7 mg/L as CaCO₃ and indicated “soft” water throughout the monitored watersheds.

Nutrient concentrations varied among sites and within watersheds during 2012 (Table 11). The median total ammonia value for all sites in 2012 was 0.04 mg/L as N with individual observations ranging from <0.01 mg/L as N at Tributary to Michaux Creek (MCX-04) to 0.47 mg/L as N at Stoney Creek (APR-02). The elevated concentration of ammonia nitrogen at the Stoney Creek site was unexpected due to its location in a relatively undeveloped portion of the county. The median nitrate+nitrite nitrogen concentration for all reaches in 2012 was 0.17 mg/L as N, with individual measurements ranging from 0.02 mg/L as N at Cattle Creek (APR-04) to 0.80 mg/L as N at Marine Spring Branch (JR-08). Similarities of the stream reaches where observations of high nitrate+nitrite nitrogen concentrations (>0.50 mg/L as N) were observed included immediate upstream dense residential land use and diminished riparian areas within their respective watersheds.

Measureable levels of dissolved phosphorus were observed at all sites in 2012 ranging from 0.02 mg/L as P at Tributary to the James River (JR-06) to 0.24 mg/L as P at Fleets Branch (APR-01). The median value observed for all sites assessed was 0.05 mg/L as P. Total phosphorus concentrations ranged from 0.03 mg/L as P at the two Tributary to the James River sites within the Robious Landing Park (JR-06 and JR-07) to 0.37 mg/L at Fleets Branch (APR-01). In 2012 the median total phosphorus value was measured at 0.06 mg/L as P. Overall, nutrient concentrations as measured by ammonia nitrogen and dissolved/total phosphorus were consistently higher at the Fleets Branch (APR-01) and Stoney Creek (APR-02) sites as compared to other reaches in 2012. While the activities within the watershed of Fleets Branch may account for this increased nutrient input (dense housing and university), it is unclear why the relatively undeveloped Stoney Creek exhibits similar traits. Further sampling in 2013 is hoped to shed some insight into this observation.

Table 11. Observations of nutrients among 15 monitored sites in Chesterfield County, 2012. Greatest values observed for each parameter are in bold type.

Site Number	Total Ammonia (mg/L as N)	Nitrate+Nitrite (mg/L as N)	Dissolved Phosphorus (mg/L as P)	Total Phosphorus (mg/L as P)
APR-01	0.38	0.56	0.24	0.37
APR-02	0.47	0.05	0.18	0.24
APR-03	0.12	0.04	0.20	0.30
APR-04	0.02	0.02	0.07	0.09
JR-04	0.04	0.35	0.04	0.06
JR-05	0.01	0.05	0.03	0.04
JR-06	0.02	0.14	0.02	0.03
JR-07	0.06	0.07	0.03	0.03
JR-08	0.03	0.80	0.03	0.04
JR-09	0.02	0.75	0.03	0.04
MCX-01	0.12	0.12	0.04	0.06
MCX-02	0.04	0.17	0.05	0.06
MCX-03	0.02	0.35	0.06	0.09
MCX-04	<0.01	0.69	0.05	0.06
MCX-05	0.01	0.25	0.07	0.18

The levels of total suspended solids ranged from <0.01 mg/L at Tributary to the James River (JR-07) and at Michaux Creek (MCX-01) to 34.1 mg/L at the uppermost Michaux Creek site (MCX-05). At this site, total suspended solids were visibly noticeable in the stream with the water presenting a turbid appearance. With the exception of this Michaux Creek (MX-05) site, all reach measurements conducted in 2012 were less than 10.0 mg/L. Biochemical Oxygen Demand determinations conducted in 2012 were generally low with values ranging from <2.0 mg/L at ten sites to 11.8 mg/L at the uppermost Michaux Creek site (MCX-05). No BOD measurements observed in 2012 were indicative of severe organic enrichment.

Fecal coliform densities ranged from < 2 MPN/100ml at Spring Creek (JR-04) and Roberts Branch (JR-09) to ≥ 1600 MPN/100ml the Tributary to the James River (JR-06). In 2012, *E. coli* determinations were continued as a supplement to the permit specified analyses to better compare bacterial impairment to current VADEQ water quality standards. The current recreation contact level of *E. coli* established by the VADEQ as of January 2011 is 235 CFU/100ml. The CFU or “Colony Forming Units” unit of measure specified by VADEQ is comparable to the Mean Probable Number or “MPN” designation used by the Chesterfield County contract laboratory. During 2012, three streams had *E. coli* measurements that were greater than the 235 MPN/100ml state standard. These observations were made at Fleets Branch (APR-01; 235.9 MPN/100ml), the Tributary to the James River at Ashwell Drive (JR-05; 261.3 MPN/100ml) and at the Tributary to the James River in Robious Landing Park (JR-06; 686.7 MPN/100ml). A revisit to these sites to evaluate these elevated levels of *E. coli* was conducted on April 25th, 2012. Samples were obtained and analyzed in the Environmental Engineering Water Quality Laboratory using the ColiScan Easygel method. The results of the samples obtained at this time confirmed increased densities of *E. coli* at the Fleets Branch reach (480 CFUs/100ml) and indicated no violations of the state *E. coli* standard at the Tributary to the James River reaches (JR-05; 80 CFUs/100ml and JR-06; 20 CFUs/100ml).

Future Approaches

In 2013, monitoring will continue at this set of stream reaches to gain further insight to their nature. The Virginia Stream Condition Index will continue to be calculated and will be further correlated with the current protocol with a goal of transitioning to its use for alignment with existing state programs. Supplemental *E. coli* densities will again be collected at each monitored site to allow for comparison to current Department of Environmental Quality water quality standards. Additionally, statistical analysis and correlation of the biological, habitat and chemical data will be conducted as needed in the hopes of establishing useful and mathematically valid predictive tools of water quality.

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